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Number 4

# Mariners Weather Log

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Cover: Heavy breakers pound the New England coast during the infamous "Blizzard of '78." See article on page 255. Photo courtesy of Bart A. Piscitello.

# Mariners Weather Log

**Editor: Elwyn E. Wilson**
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**July 1978**
**Volume 22 Number 4**
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Mariners Weather Log

# A REVISED ATLANTIC TROPICAL CYCLONE CLIMATOLOGY

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For a number of years the standard reference to tropical-cyclone tracks and related statistical summaries for the North Atlantic tropical-cyclone basin has been Cry's (1965) Tropical Cyclones of the North Atlantic Ocean. Now long out-of-print, this work, which covered the period from 1871 through 1963, is currently being revised and updated by the National Hurricane Center, Coral Gables, Fla., and the National Climatic Center, Asheville, N.C. The new publication, Tropical Cyclones of the North Atlantic Ocean, 1871-1977, will be available within the next few months. Information on obtaining copies will be publicized in a future issue of the Mariners Weather Log.

The revision will contain essentially the same tracks used by Cry for the period through 1963, although several corrections and additions have been made based on additional information which has become available to the National Hurricane Center. Two examples of these changes include the addition of a storm for the 1945 season, based on research by Fernandez-Partegas (1966), and the adjustment of the track of the second tropical cyclone of 1929 to pass over Andros Island, based on the findings of Sugg, et al. (1971).

The additional storm track maps for each year 1964 through 1977 are based on information published annually in the Monthly Weather Review and Mariners Weather Log, augmented by additional data on file at the National Hurricane Center and by case studies such as that given by Spiegler (1971). Beginning with 1968, the annual storm track maps will include any subtropical stages (Simpson, 1973; Hebert, 1973) of the storm tracks as documented by Hebert and Poteat (1975) for the years 1968 through 1971 and as contained in the Monthly Weather Review for the later years.

Much of the material presented in the revision will be of interest to mariners. Some extracts of text, figures, and tables are presented here. In the discussions which follow, the term tropical cyclone refers to both tropical storms (maximum sustained wind 34 to 63 kn) and hurricanes (maximum sustained wind 64 kn or over). Tropical depressions (sustained winds less than 34 kn) unless otherwise indicated are excluded.

## USE OF COMPUTER TECHNOLOGY

Hope and Neumann (1971) and Hill (1976) point out the increasing use of computer technology in tropical-cyclone climatology, and indeed the revised Atlantic storm climatology makes extensive use of the computer's ability to accurately summarize data, prepare figures, and plot storm tracks. Figure 1, for example, shows a computer rendition of the tracks of all recorded Atlantic tropical cyclones 1886-1977. Although this chart has limited utility because of the large number of storm tracks, it is an excellent example of the computer's ability to perform a task virtually impossible by conventional means. The chart also serves to outline the areal extent of the Atlantic tropical cyclone basin which is seen to include much of the North Atlantic, the Caribbean Sea, the Gulf of Mexico, and most adjacent land masses. Charts similar to figure 1, but for monthly and 10-day periods, will be included in the revision.

## IMPORTANCE OF SHIP OBSERVATIONS

Prior to the beginning of organized aircraft reconnaissance in 1944, the documentation of the storm tracks depicted in figure 1 was almost exclusively provided by ship reports. Before the introduction of radio communication, observations from ships were not received until the vessels returned to port, sometimes months later. Although such late reports were of no immediate value for forecasting purposes, they were used extensively for the construction of portions of storm tracks over the oceans. The first radio message reporting a hurricane was sent on August 26, 1909, by the SS CARTAGO from the southern Gulf of Mexico near the coast of Yucatan. The amount and quality of marine weather data have increased gradually during the succeeding years. Dur-

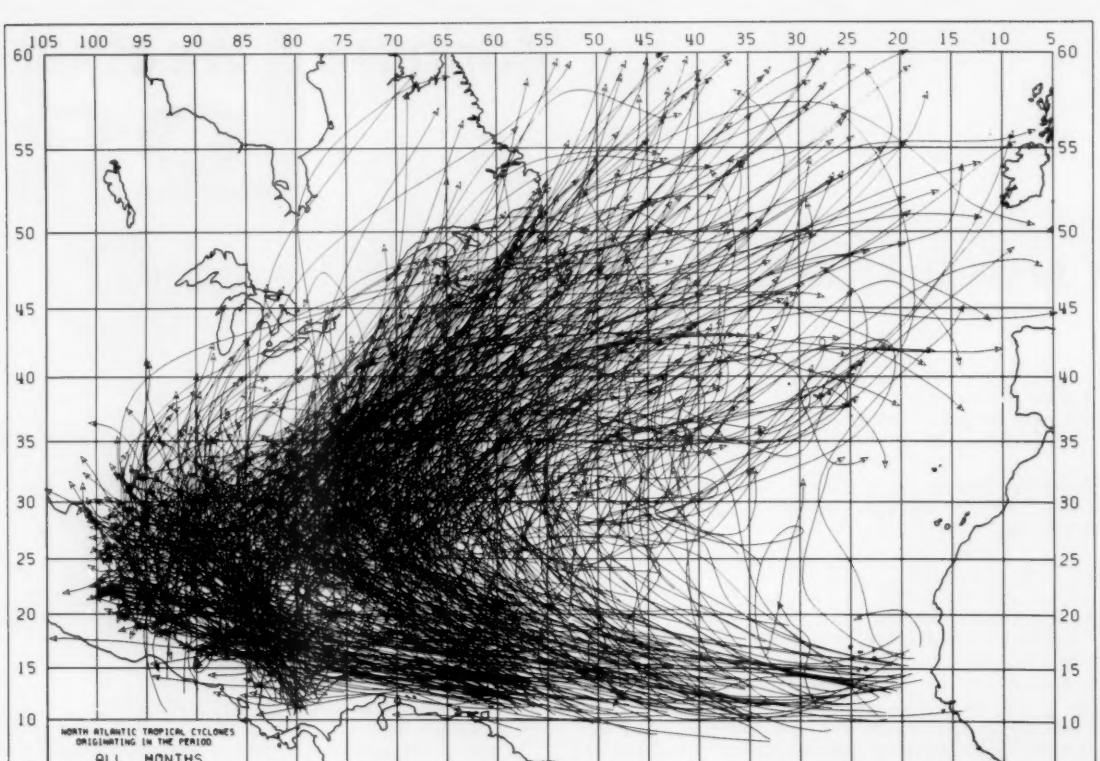


Figure 1.--Tracks of 761 known Atlantic tropical cyclones that reached at least tropical-storm intensity over the 92-yr period 1886 through 1977.

ing the June to November tropical-cyclone season of 1935, more than 21,000 observations were received from tropical portions of the Atlantic. By 1959 the number of observations from ships during the corresponding period exceeded 64,000. Since the early 1960's the number has increased less rapidly, due to changes in the characteristics of the shipping industry. Although aircraft, weather satellites, and radar are of great importance in detection and tracking tropical cyclones, the National Hurricane Center continues to regard ship reports as an indispensable part of the information required to enable it to fulfill its responsibility in the detection, tracking, and forecasting of tropical cyclones.

## FREQUENCY OF ATLANTIC TROPICAL CYCLONES

Over the 107-yr period 1871 through 1977, 850 tropical cyclones (tropical storms or hurricanes) of various sizes and intensities were recorded over the North Atlantic tropical-cyclone basin. For the years 1885 and earlier, documentation is too fragmented to determine storm intensity in every case. Subsequently, however, with certain limitations it has been possible to determine the intensity classification of all recorded tropical cyclones. Over this 92-yr period beginning in 1886, 761 tropical cyclones were recorded. These are shown in figure 1. Of these, 448 or about 59 percent reached hurricane intensity. The total number of tropical cyclones (tropical storms and hurricanes) and hurricanes alone for each year is given in figure 2. Note that the number of tropical cyclones occurring in individual years varies from 1 in 1890 and 1914 to 21 in 1933, while the number of tropical cyclones reaching hurricane strength varies from none in both 1907 and 1914 to 12 in 1969. A plot of the frequency distribution of the number of storms occurring each year is given in figure 3. Insofar as the total number of storms is concerned, a unique modal (most frequently occurring) value cannot be identified. In the case of hurricanes, however, the distribution is much more orderly with 4 hurricanes per year occurring most frequently over the period of record, 1886 through 1977.

The question arises as to the accuracy of these data. Subsequent to 1944, improved detection methods make it virtually impossible for a storm to remain undetected throughout its life history. However, prior to the weather satellite era which began about 1960, some storms were already fully developed hurricanes when detected by aircraft, ship, or land station. Be-

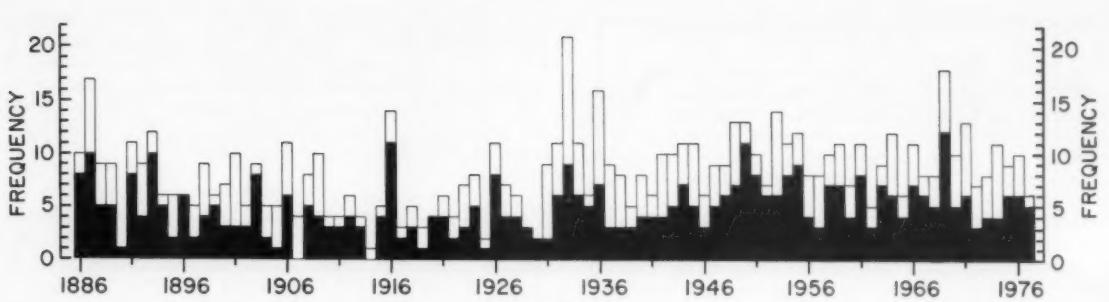


Figure 2.--Annual distribution of 761 recorded Atlantic tropical cyclones that reached at least tropical-storm strength (open bar) and 448 storms that reached hurricane strength (solid bar), 1886 through 1977. The average number of such storms is 8.3 and 4.9, respectively (see table 1).

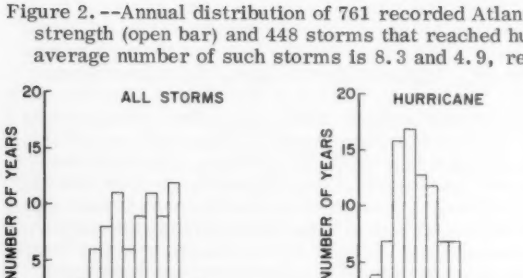


Figure 3.--Distribution of annual tropical cyclones that reached at least tropical-storm strength (left) and hurricane strength (right), 1886 through 1977.

fore the introduction of organized aircraft reconnaissance in 1944, it was possible and indeed likely that a few weak and short-duration storms were never detected. However, once a storm became well-organized and more intense, the large size of the circulation makes it unlikely that it would not be detected by at least one ship or land station at some point along its track. For these reasons the frequencies presented in figures 2 and 3 are reasonably reliable, even back to 1886.

Visual inspection of figure 2 discloses long-term trends in the data. Over the period 1910 through 1930, for example, the frequency of tropical cyclones averaged only 5.2, and the frequency of those reaching hurricane strength averaged only 3.5 storms per year. This compares to significantly higher totals both before and after this 21-yr period. Reasons for these long-period fluctuations in storm frequency are not apparent but are probably related to subtle changes in the global atmospheric circulation and sea-surface temperature patterns. The subject is currently under investigation by a number of authors. Wendland (1977), for example, discusses the effects of sea-surface temperatures on long-term tropical-cyclone frequencies.

Because of these trends, the average frequency of tropical cyclones depends on the number of years included in the summary. In table 1 the average frequency has been summarized over three different time periods, 1886 to 1977, 1910 to 1930, and 1944 to 1977. The 34-yr period 1944 to 1977 probably best represents conditions as they currently exist, although a slight decline in North Atlantic tropical cyclone activity has been noted in recent years. The decline is particularly apparent in regard to the number of storms affecting the United States in recent years. This topic is covered later.

Table 1.--Total and average number of tropical cyclones (excluding depressions and including subtropical systems) beginning in each month

| | | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tropical storms and hurricanes | 1886-1977 | 0 | 1 | 1 | 0 | 13 | 49 | 58 | 176 | 257 | 168 | 33 | 5 | 761 |
| Average | | 0.0 | * | * | 0.0 | 0.1 | 0.5 | 0.6 | 1.9 | 2.8 | 1.8 | 0.4 | 0.1 | 8.3 |
| Hurricanes only | | 0 | 0 | 1 | 0 | 3 | 21 | 31 | 123 | 164 | 83 | 15 | 2 | 448 |
| Average | | 0.0 | 0.0 | * | 0.0 | * | 0.2 | 1.5 | 1.4 | 1.8 | 0.9 | 0.2 | * | 4.9 |
| Tropical storms and hurricanes | 1910-1930 | 0 | 0 | 0 | 0 | 0 | 7 | 7 | 24 | 39 | 26 | 6 | 0 | 109 |
| Average | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.3 | 1.1 | 1.9 | 1.2 | 0.3 | 0.0 | 5.2 |
| Hurricanes only | | 0 | 0 | 0 | 0 | 0 | 4 | 4 | 21 | 29 | 12 | 4 | 0 | 74 |
| Average | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.2 | 1.0 | 1.4 | 0.6 | 0.2 | 0.0 | 3.5 |
| Tropical storms and hurricanes | 1944-1977 | 0 | 1 | 0 | 0 | 7 | 19 | 28 | 81 | 120 | 61 | 12 | 3 | 332 |
| Average | | 0.0 | * | 0.0 | 0.0 | 0.2 | 0.6 | 0.8 | 2.4 | 3.5 | 1.8 | 0.4 | 0.1 | 9.8 |
| Hurricanes only | | 0 | 0 | 0 | 0 | 2 | 8 | 13 | 55 | 80 | 39 | 5 | 1 | 203 |
| Average | | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.4 | 1.6 | 2.3 | 1.1 | 0.2 | * | 6.0 |

*Asterisk (*) indicates less than 0.05 storms.*

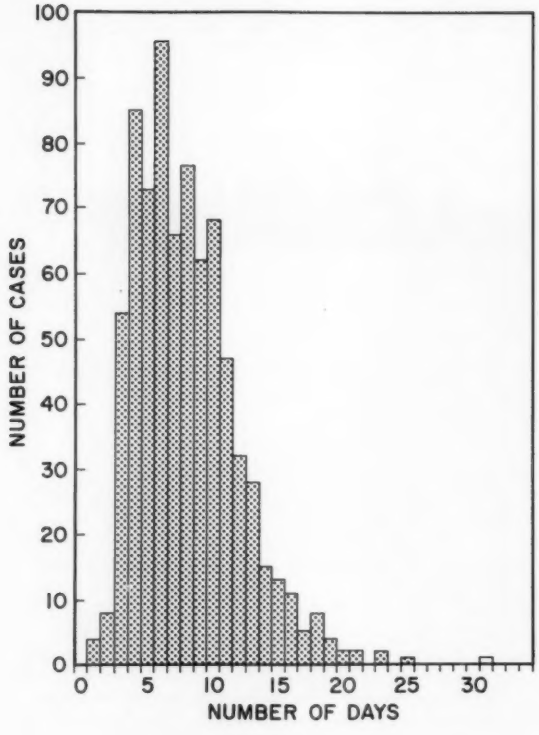


Figure 4.--Distribution of observed duration (number of calendar days) of 761 recorded Atlantic tropical cyclones, 1886 through 1977. Distribution includes tropical-depression and early extratropical stage (if recorded).

Note that table 1 gives the number of storms beginning in each month. Thus, a storm which reaches tropical-storm strength on August 31 and hurricane strength on September 3 would be classified as a hurricane beginning in August. No entries would be made for September. This convention may differ somewhat from other summaries of similar data.

## DURATION OF TROPICAL CYCLONES

Based on all Atlantic tropical-cyclone tracks 1886-1977 (fig. 1) the duration of a tropical cyclone (including the tropical depression and early extratropical stage) averaged about 8 days but, as shown on figure 4, has varied from 1 to 31 days. The modal (most frequently occurring) duration is seen to be 6 days. Since the ability to detect tropical cyclones earlier and track them for longer periods has improved in recent years, the data given in figure 4 are somewhat biased, and the average duration of a tropical cyclone currently stands at about 9 days. Very brief storms typically form in the Gulf of Mexico and dissipate after moving over adjacent land areas. Hurricanes of long duration include Ginger (1971) which was tracked for 31 days and Inga (1969) for 25 days. Both of these storms meandered slowly around the western and central Atlantic for much of their existence. Other long-duration storms are those which form in the eastern Atlantic, move steadily westward, recurve just before reaching the United States and move northeastward across the open Atlantic.

## DAILY FREQUENCIES

Figure 5 gives the incidence of tropical cyclones over the North Atlantic basin on a daily basis for the 8-mo period that comprises the principal season. For easier interpretation, the raw frequency data have been smoothed using a 9-day moving average. This smoothing process removes most of the "noise" inherent in the raw data, yet preserves the large-scale seasonal cycles.

These seasonal fluctuations in frequency include a

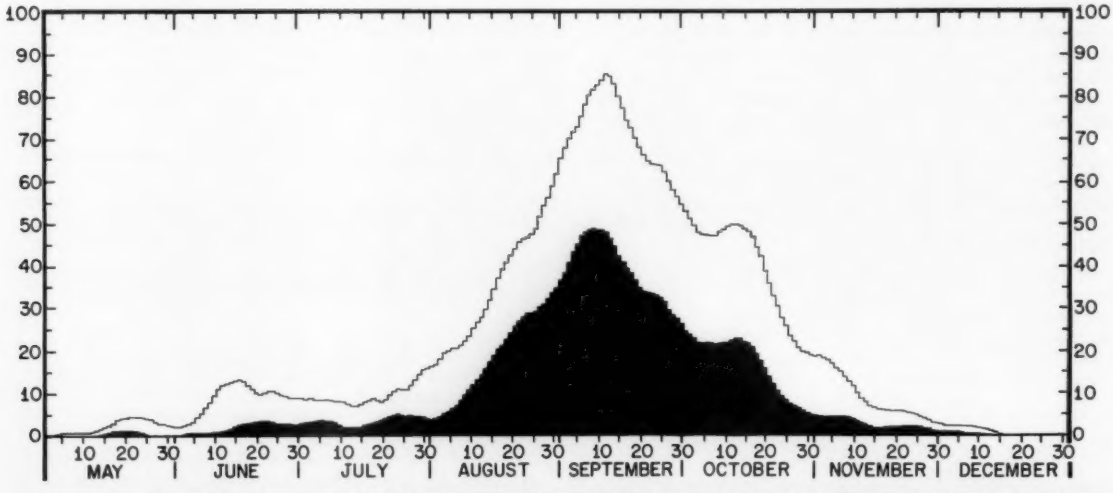


Figure 5.--Tropical storms and hurricanes (open bar) and hurricanes (solid bar) observed on each day, May 1 to December 30, 1886 through 1977. Data have been smoothed by a 9-day moving average.

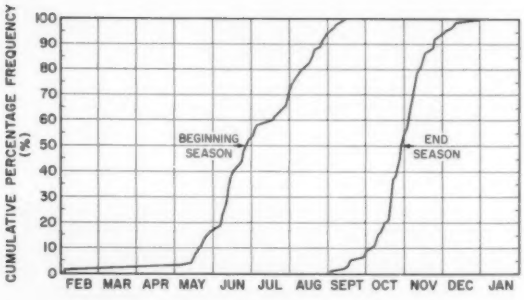


Figure 6.--Cumulative percentage frequency distribution of beginning and ending dates of Atlantic tropical-cyclone season, 1886 through 1977. (Dates are of first and last recorded position with at least tropical-storm strength.

slight maximum around mid-June, a slight decline (but a nearly constant occurrence rate) between June 20 and July 20, and a gradual increase in frequency until just prior to mid-September. A somewhat irregular decline in average frequency occurs thereafter, interrupted by a slight increase in overall storm frequency in mid-October.

The official Atlantic hurricane season extends from June 1 through November 30. However, as seen from figure 6, the season occasionally begins or ends outside of this period. This figure presents a cumulative percentage frequency distribution of the date of detection of the first and the date of dissipation of the last tropical cyclone of storm or hurricane intensity for each season. The median (midpoint of the distribution) starting date is June 26 and the median ending date is October 29. Figure 6 shows that the 1977 hurricane season which began on August 30 was one of the latest starting dates on record, a still later starting date having been observed only 6 percent of the time over the 92-yr period 1886-1977.

There are no significant statistical relationships between the beginning and ending dates of the tropical-cyclone season; that is, seasons which began early did not necessarily end early (or late), and seasons which began late did not necessarily end late (or early). However, there is a weak statistical relationship between the starting date and the number of storms such that, as expected, seasons which start early tend to have more storms. However, a low correlation indicates that there are many exceptions to this rule.

## TROPICAL CYCLONES AFFECTING THE UNITED STATES

Of the 651 tropical cyclones recorded over the Atlantic basin from 1899 to 1977, 257 or about 40 percent crossed or passed immediately adjacent to the United States mainland. The year-to-year totals are given in figure 7. The earlier years 1886 to 1898 are not included in this figure because of uncertainties in the intensities of certain storms which affected unpopulated coastal areas. These 257 storms over the 79-yr period give an average frequency of 3.3 storms (tropical storms and hurricanes) per year which affected the United States. As shown on figure 7, there have been 9 occasions when 6 or more storms have affected the United States with the years 1909 and 1916 each having 8 storms. However, the frequencies seem to have been declining in recent years. As mentioned earlier, the reason for such "cycles" is not readily apparent but is probably related to subtle large-scale atmospheric processes. In spite of the decline, there is no meteorological reason to expect that the frequencies will not eventually increase as they did, for example, beginning in 1932, after 15 yr of mostly below-normal frequencies of storms affecting the United States, 1917-1931.

The storms depicted in figure 7 range from weak tropical storms to intense hurricanes. A total of 140 or about 54 percent of these storms were classified as hurricanes upon crossing or skirting the U.S. coastline. This averages to slightly more than 5 hurricanes every 3 yr.

To relate hurricane intensity to damage potential, the National Hurricane Center has adopted the Saffir/Simpson (1977) Hurricane Scale. This descriptive scale, over a range from 1 to 5, classifies hurricanes according to the damage potential with category 1 referring to the weaker and category 5 to the most intense hurricanes. Hebert and Taylor (1975) classified all hurricanes that affected the United States during this century according to the Saffir/Simpson scale. They found 54 major hurricanes (category 3 or higher). This means that about twice every 3 yr a hurricane has crossed the U.S. coastline with a potential of causing billions of dollars in damage and hundreds of deaths. The authors (Hebert and Taylor) call attention to the marked increase in coastal population levels and construction and the limited hurricane-experience levels of many coastal residents. Additional information on the Saffir/Simpson scale will be given in the revised edition of Atlantic tropical-cyclone climatology referred to in the opening paragraph.

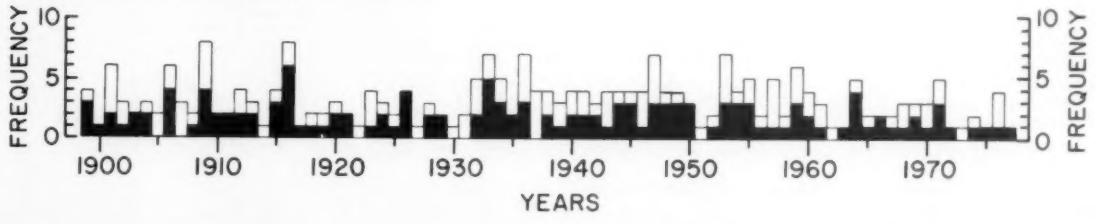


Figure 7.--Annual distribution of 257 Atlantic tropical storms and hurricanes (open bars) and 140 hurricanes (solid bars) that have crossed or passed immediately adjacent to the U.S. coastline (Texas to Maine), 1899 through 1977. The average number of such storms is 3.3 and 1.8, respectively.

ACKNOWLEDGMENTS

Most of the material contained in this summary is taken from the proposed Tropical Cyclones of the North Atlantic Ocean, 1871-1977, authored by C.J. Neumann, G.W. Cry, E.L. Caso, and B.R. Jarvinen of the National Weather Service. This study has been underway at the National Hurricane Center for a number of years, and it is impossible to acknowledge all the assistance received. However, special thanks to Robert Carrodus, Scientific Illustrations Coordinator of the NOAA Atlantic Oceanographic and Meteorological Laboratory, for the preparation of figures 2 through 7.

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THE MARINERS WEATHER LOG WELCOMES ARTICLES AND LETTERS FROM MARINERS RELATING TO METEOROLOGY AND OCEANOGRAPHY, INCLUDING THEIR EFFECTS ON SHIP OPERATIONS.

# WESTERN NORTH PACIFIC TYPHOONS, 1977

Extracted from Annual Typhoon Report, 1977, U.S. Fleet Weather Central, Joint Typhoon Warning Center, Guam, Mariana Islands.

The western North Pacific experienced the smallest number of typhoons since the formation of the Joint Typhoon Warning Center (JTWC) in 1959 during 1977. Of the 21 numbered tropical cyclones occurring during 1977 (table 2), only 11 developed to mature typhoons, 8 peaked out as tropical storms, and 2 did not develop beyond depression stages. Tables 3 and 4 show that both the number of tropical storms and typhoons were well below the quantity normally observed. During the season only Babe reached the 130-kn intensity necessary to be classified as a supertyphoon. January through June were completely void of typhoons and had only two tropical storms, Patsy in March and Ruth in June. This early season lull in activity was similar to that observed during 1973 and 1975. Tropical cyclone occurrences were near normal during July, but fell to a record low for August, when no typhoons and only a single tropical storm were observed. During late July the southwest monsoon of India and Southeast Asia became very deep and intense. It extended anomalously into the western North Pacific and persisted for weeks. The monsoon trough was oriented in an east-northeast to west-southwest direction from Hainan Island to the Bonin Islands. Several cyclonic eddies formed within the trough as monsoon depressions; i.e., systems characterized by broad surface circulation centers, highly asymmetric wind fields, surface winds less than 34 kn, greatest intensity at 5,000 to 10,000 ft (1,470 to 2,940 m), and strong vertical shear.

Upon relaxation of the deep, southwest monsoon flow, tropical storm Wilda developed, but did not exceed 45-kn intensity in the environment of strong vertical shear. As Wilda moved east of Japan, she caused the monsoonal flow over the western Pacific to move toward the north, rather than toward the climatologically favored regions where tropical cyclones normally develop. This northward flow toward low pressure continued as several extratropical systems developed near the sea of Japan, south of the normal regions for extratropical cyclogenesis in August. About the middle of August, the deep, southwest monsoon flow again intensified, and again several monsoon depressions formed. When the monsoon finally weakened, tropical storm Amy developed, but barely to 40 kn. Amy again drew the western Pacific region of low pressure far north of its normal position, preventing establishment of a significant near-equatorial trough (NET). In fact, during much of August, pressures were much above normal in the Tropics, and easterly winds dominated the equatorial regions, helping to prevent cyclogenesis. By early September pressures had fallen in the Tropics, flow was back to normal, and supertyphoon Babe developed in the NET, south of Guam. The remainder of the 1977 season for both tropical storms and typhoons was near normal.

During 1977, 26 Tropical Cyclone Formation Alerts were issued. Of these, 20 or 77 percent developed into significant tropical cyclones. No formation alert

Table 2.--Western North Pacific tropical cyclones, 1977

| Name | Intensity | Period of Warning | Maximum surface wind (kn) | Minimum observed sea level pressure(mb) |
|---|---|---|---|---|
| Patsy | TS | March 23-31 | 50 | 981 |
| Ruth | TS | June 14-17 | 60 | 980 |
| Sarah | TY | July 16-21 | 75 | 970 |
| Thelma | TY | July 21-26 | 85 | 957 |
| Vera | TY | July 28-August 1 | 110 | 926 |
| Wanda | TS | July 31-August 4 | 45 | 986 |
| Amy | TS | August 20-23 | 40 | 990 |
| Babe | STY | September 2-10 | 130 | 906 |
| Carla | TS | September 3-5 | 35 | 994 |
| Dinah | TY | September 14-23 | 75 | 964 |
| Emma | TS | September 15-20 | 60 | 966 |
| Freda | TS | September 23-25 | 55 | 997 |
| Gilda | TY | October 3-10 | 70 | 968 |
| Harriet | TS | October 16-20 | 55 | 984 |
| Ivy | TY | October 21-27 | 90 | 945 |
| Jean | TY | Oct. 28-31, Nov. 2-3 | 65 | 972 |
| Kim | TY | November 6-17 | 125 | 916 |
| Lucy | TY | Nov. 28-Dec. 7 | 115 | 919 |
| Mary | TY | Dec. 20-Jan. 3 | 100 | 947 |

TY - typhoon; TS - tropical storm; STY - supertyphoon

Table 3.-- Frequency of tropical storms and typhoons by month and year

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average (1945-58) | 0.4 | 0.1 | 0.4 | 0.5 | 0.8 | 1.3 | 3.0 | 3.9 | 4.1 | 3.3 | 2.7 | 1.1 | 22.0 |
| 1959 | 0 | 1 | 1 | 1 | 0 | 0 | 2 | 6 | 6 | 4 | 2 | 2 | 26 |
| 1960 | 0 | 0 | 0 | 1 | 1 | 2 | 3 | 10 | 3 | 4 | 1 | 1 | 27 |
| 1961 | 1 | 1 | 1 | 1 | 3 | 2 | 5 | 4 | 6 | 5 | 1 | 1 | 31 |
| 1962 | 0 | 1 | 0 | 1 | 2 | 0 | 6 | 7 | 3 | 5 | 3 | 1 | 30 |
| 1963 | 0 | 0 | 0 | 1 | 1 | 2 | 4 | 3 | 5 | 5 | 0 | 2 | 23 |
| 1964 | 0 | 0 | 0 | 0 | 2 | 2 | 7 | 9 | 7 | 6 | 6 | 1 | 40 |
| 1965 | 2 | 2 | 1 | 1 | 2 | 3 | 5 | 6 | 7 | 2 | 2 | 1 | 34 |
| 1966 | 0 | 0 | 0 | 1 | 2 | 1 | 5 | 6 | 7 | 3 | 2 | 1 | 30 |
| 1967 | 1 | 0 | 2 | 1 | 1 | 1 | 6 | 6 | 7 | 4 | 3 | 1 | 34 |
| 1968 | 0 | 0 | 0 | 1 | 1 | 1 | 3 | 6 | 3 | 6 | 4 | 0 | 27 |
| 1969 | 1 | 0 | 1 | 1 | 0 | 0 | 3 | 4 | 3 | 3 | 2 | 1 | 19 |
| 1970 | 0 | 1 | 0 | 0 | 0 | 2 | 2 | 6 | 4 | 5 | 4 | 0 | 24 |
| 1971 | 1 | 0 | 1 | 2 | 4 | 2 | 0 | 4 | 6 | 4 | 2 | 0 | 26 |
| 1972 | 1 | 0 | 0 | 0 | 1 | 2 | 6 | 5 | 4 | 5 | 2 | 3 | 29 |
| 1973 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 5 | 2 | 4 | 3 | 0 | 21 |
| 1974 | 1 | 0 | 1 | 1 | 1 | 4 | 4 | 5 | 5 | 4 | 4 | 2 | 32 |
| 1975 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 4 | 5 | 5 | 3 | 0 | 20 |
| 1976 | 1 | 1 | 0 | 2 | 2 | 1 | 0 | 3 | 6 | 1 | 1 | 1 | 25 |
| 1977 | 0 | 0 | 1 | 0 | 0 | 1 | 4 | 1 | 5 | 4 | 2 | 1 | 19 |
| Average (1959-77) | 0.5 | 0.4 | 0.4 | 0.6 | 1.2 | 1.6 | 4.0 | 5.0 | 4.9 | 4.2 | 2.5 | 1.2 | 27.9 |

Table 4.-- Frequency of typhoons by month and year

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average (1945-58) | 0.4 | 0.1 | 0.3 | 0.4 | 0.7 | 1.1 | 2.0 | 2.9 | 3.2 | 2.4 | 2.0 | 0.9 | 16.3 |
| 1959 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 5 | 3 | 3 | 2 | 1 | 20 |
| 1960 | 0 | 0 | 0 | 1 | 0 | 2 | 2 | 6 | 0 | 4 | 1 | 1 | 19 |
| 1961 | 0 | 0 | 1 | 0 | 2 | 1 | 3 | 3 | 5 | 3 | 1 | 1 | 20 |
| 1962 | 0 | 0 | 0 | 1 | 2 | 0 | 5 | 7 | 2 | 4 | 3 | 0 | 24 |
| 1963 | 0 | 0 | 0 | 1 | 1 | 2 | 3 | 3 | 3 | 4 | 0 | 2 | 19 |
| 1964 | 0 | 0 | 0 | 0 | 2 | 2 | 6 | 9 | 3 | 4 | 4 | 1 | 36 |
| 1965 | 1 | 0 | 0 | 1 | 2 | 2 | 4 | 3 | 5 | 3 | 1 | 0 | 21 |
| 1966 | 0 | 0 | 0 | 1 | 2 | 1 | 3 | 6 | 4 | 2 | 0 | 1 | 20 |
| 1967 | 0 | 0 | 1 | 1 | 0 | 1 | 3 | 4 | 4 | 3 | 3 | 0 | 20 |
| 1968 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 4 | 3 | 5 | 4 | 0 | 20 |
| 1969 | 1 | 0 | 0 | 1 | 0 | 0 | 2 | 3 | 2 | 3 | 1 | 0 | 13 |
| 1970 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 4 | 2 | 3 | 1 | 0 | 12 |
| 1971 | 0 | 0 | 0 | 2 | 1 | 2 | 0 | 2 | 5 | 3 | 1 | 0 | 16 |
| 1972 | 1 | 0 | 0 | 0 | 1 | 1 | 4 | 4 | 3 | 4 | 2 | 2 | 22 |
| 1973 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 2 | 2 | 4 | 0 | 0 | 12 |
| 1974 | 0 | 0 | 0 | 0 | 1 | 2 | 1 | 2 | 2 | 4 | 2 | 0 | 15 |
| 1975 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 4 | 3 | 2 | 0 | 14 |
| 1976 | 1 | 0 | 0 | 1 | 2 | 2 | 3 | 0 | 4 | 1 | 0 | 0 | 14 |
| 1977 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | 2 | 1 | 11 |
| Average (1959-77) | 0.3 | 0.1 | 0.1 | 0.7 | 0.9 | 1.1 | 2.0 | 3.6 | 3.2 | 3.2 | 1.6 | 0.5 | 18.3 |

was issued for typhoon Jean. Instead, a warning was issued in order to provide more information to a U.S. Navy ship approaching the system. The average lead time between issuance of a Tropical Cyclone Formation Alert and the first warning was 21 hr, with a minimum of 4 hr with tropical storm Wanda and a maximum of 48 hr with typhoon Kim.

Only 12 multiple-storm days occurred in 1977. This was the lowest number of multiple-storm days observed since JTWC began keeping records in 1959. Like 1970 and 1975, there were no days in 1977 in which three or more western North Pacific tropical cyclones occurred simultaneously.

The 1977 tropical-cyclone season was characterized by an abundance of poorly defined cyclones of relatively small radial extent of which many exhibited numerous erratic movements. The weaker cyclones were often inhibited from development by an unusually large and intense subtropical ridge and shear of the horizontal winds with height. In contrast, periods of weak steering currents resulted in five storms executing one or more loops each. Overall losses of life and property were thankfully small. Taiwan, however, survived a 3-mo drought, then experienced two of the worst typhoons in 80 yr, Vera (fig. 8) and Thelma.

The cyclone tracks shown in figures 9 to 12 are based on poststorm analysis. Dates include the period from when the storm was detected until it dissipated or became extratropical. Maximum winds are overwater estimates of sustained windspeeds for a 1-min averaging period. Individual typhoons are described in the following narratives. Times are GMT unless otherwise indicated. Tropical storm summaries can be found in the "Smooth Log" in the appropriate issue of Mariners Weather Log.

## SARAH

The first typhoon of the 1977 season did not occur until mid-July. Meteorological satellite data on the morning of July 13 showed an area of convection some 225 mi east of Koror in the Palau Islands. This tropical disturbance meandered on a 10-kn westward track and crossed Koror at 1200 on the 14th. On the 15th the system exhibited increased organization and a formation alert was issued. The disturbance took a more climatological, west-northwestward track and showed evidence of possessing multiple circulation centers.

Satellite data on the 16th hinted that the westernmost circulation center was becoming the dominant one. Reconnaissance aircraft refuted this, however, and fixed the primary center approximately 200 mi east of the satellite positions. At 0943 aircraft observed 38-kn winds at 700 mb and estimated surface winds at 25 kn. Satellite data 1 hr later showed that convection in the area had, in fact, consolidated around the aircraft-fixed circulation center.

By evening on the 16th satellite data illustrated increased organization, and at 1800 the depression was upgraded to tropical storm Sarah 30 mi east of the Philippine island of Samar. During the next 24 hr Sarah, possessing 40-kn winds, moved toward Manila at 13 kn on a west-northwest to northwest

Figure 8.--An overhead steel bridge in downtown Taipei collapsed on this bus. Five persons were killed and nine injured when it smashed two buses, two taxi cabs, and a car. Wide World Photo.

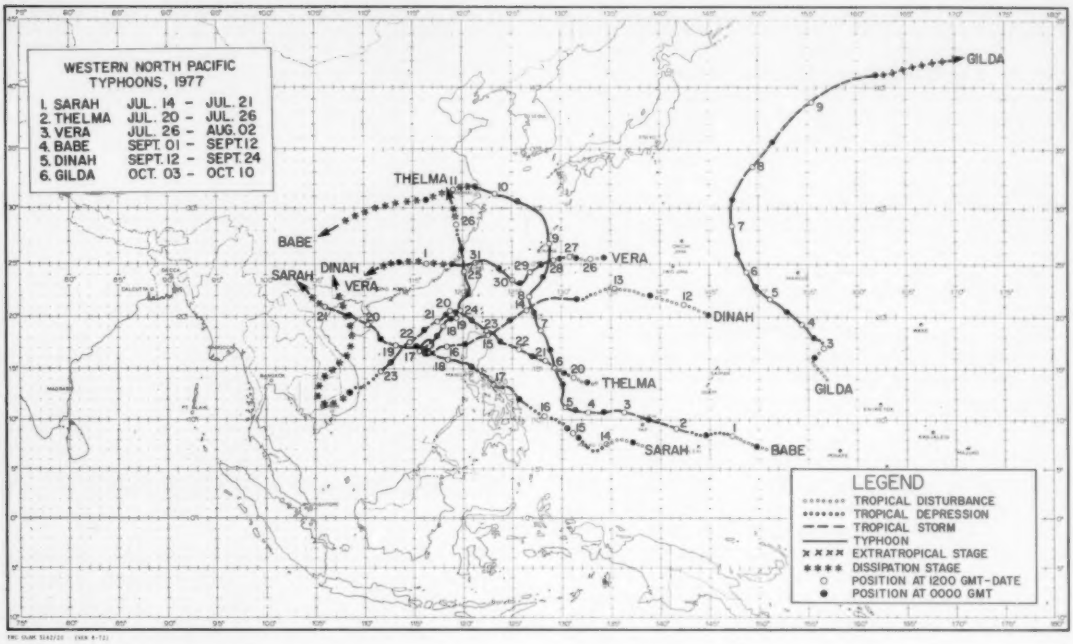


**Figure 9.--Tracks of western North Pacific typhoons, July 14 to October 10, 1977.**

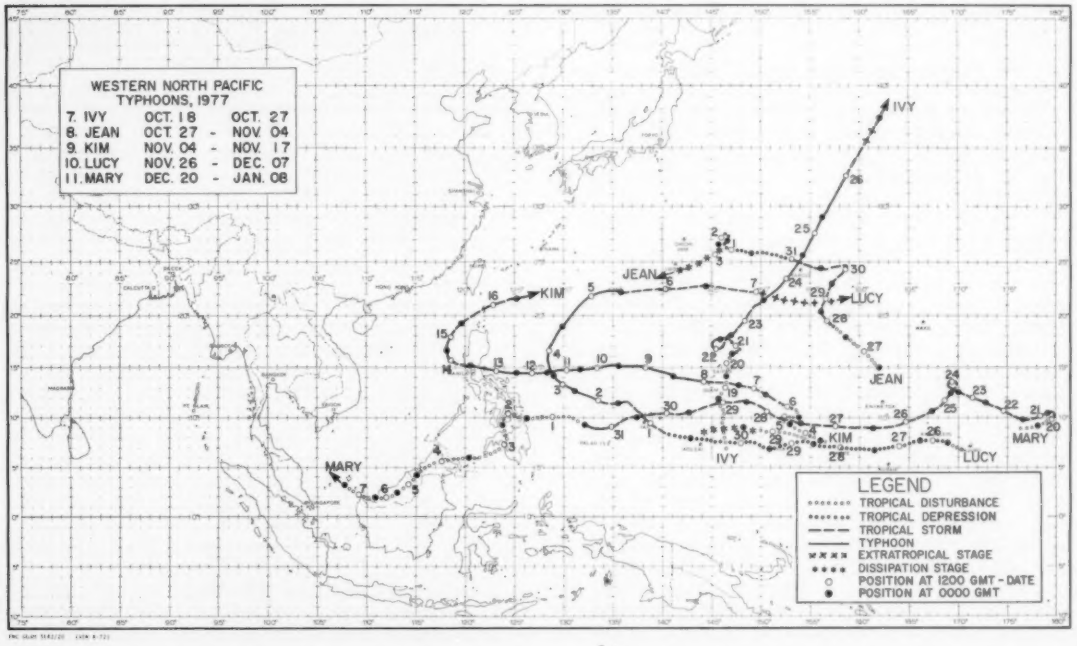


**Figure 10.--Tracks of western North Pacific typhoons, October 18, 1977, to January 8, 1978.**

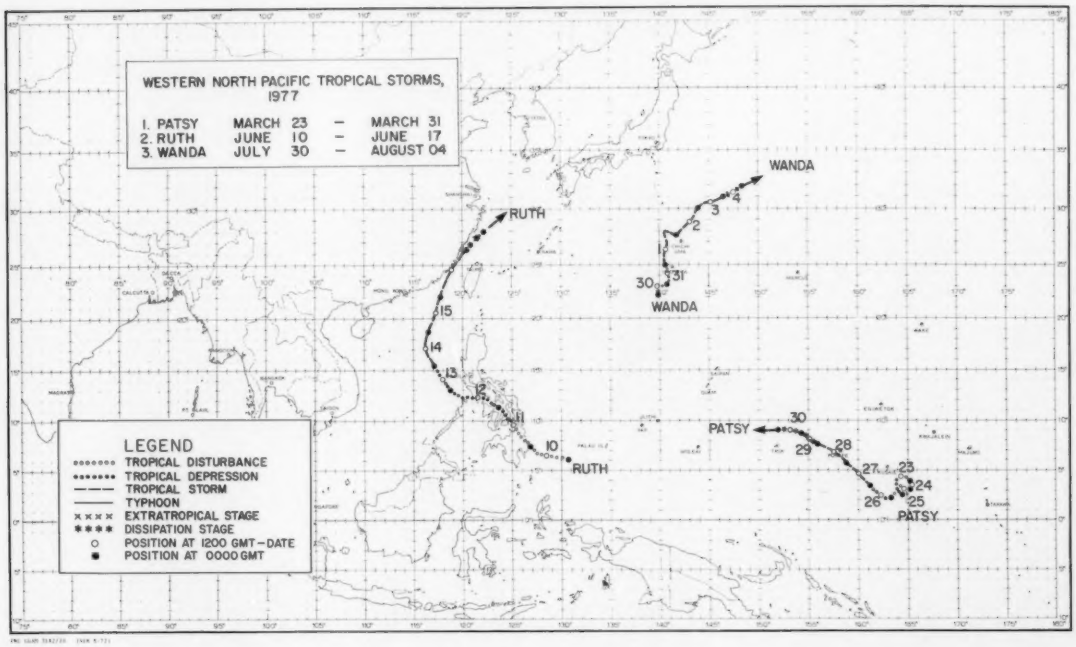


Figure 11.--Tracks of western North Pacific tropical storms, March 23 to August 4, 1977.

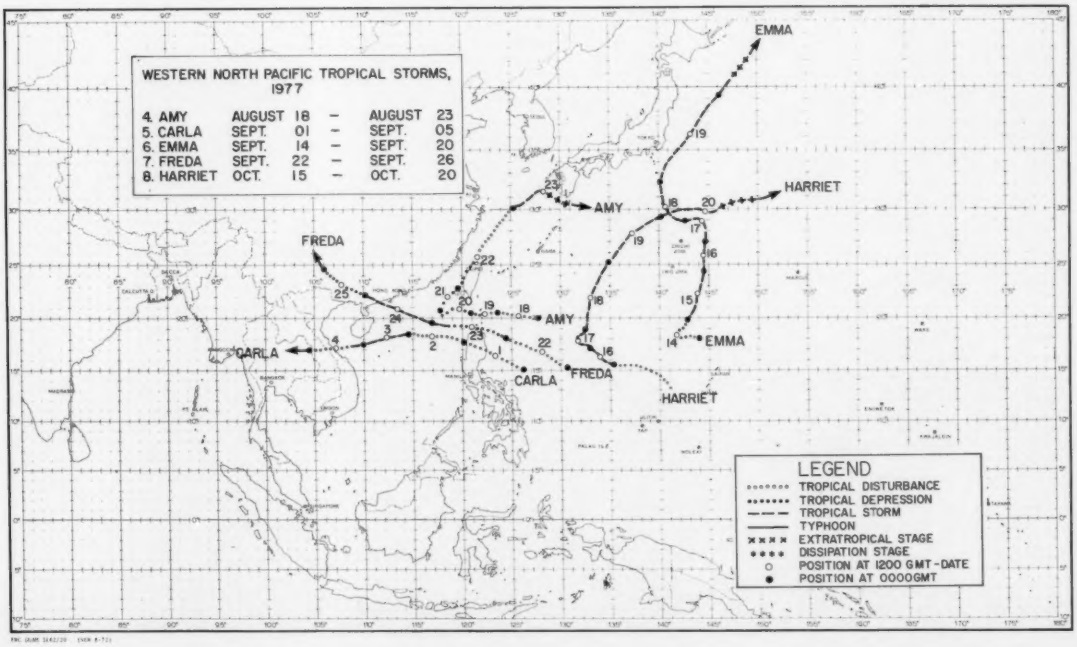


Figure 12.--Tracks of western North Pacific tropical storms, August 18 to October 20, 1977.

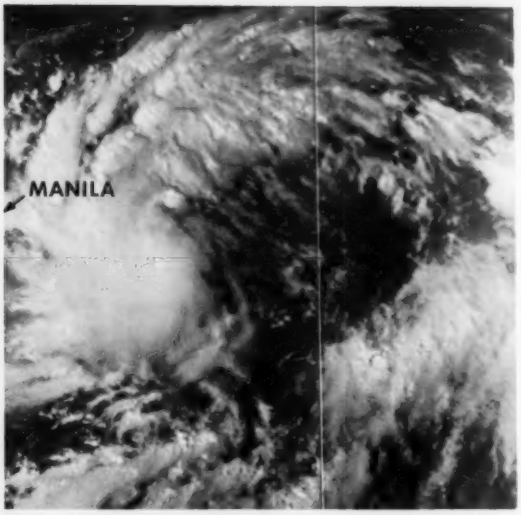


Figure 13. -- Sarah at 40-kn intensity crossing northeastern Samar at 0057 July 17. NOAA-5 imagery.

heading (fig. 13). At 2355 on the 17th Clark Air Base observed a minimum sea-level pressure of 997.3 mb and 12-kn northwesterly winds. Within 2 hr winds at the Air Base had become southerly. Synoptic reports were of great value during this period. The mountainous terrain prevented aircraft reconnaissance of the low-level circulation center, while frictional effects weakened and disorganized Sarah, making satellite positioning very difficult.

From the evening of the 16th until the morning of the 20th upper level patterns in Sarah's environment were favorable for enhancement of her upper level outflow, which would normally result in intensification. The tropical upper tropospheric trough was oriented east-west and to the north and was enhancing outflow in the north semicircle. Strong divergent winds south of the tropical storm increased outflow to the south. However, while over land, Sarah could not intensify since the latent and sensible heat required to maintain sufficient thermal and related pressure gradients were not available. The tropical storm entered the South China Sea on the afternoon of the 18th and immediately began to intensify.

On the 19th a midtropospheric low over south-central China deepened and weakened the subtropical ridge north of Sarah. She responded and turned to the northwest toward Hainan Island, still intensifying. Sarah was upgraded to a typhoon at 1800 and reached maximum intensity of 75 kn 6 hr later. At 2100 Hsi-Sha-Tao reported sustained winds (10-min average) of 60 kn from the west-southwest and a sea-level pressure of 977.5 mb.

Sarah went ashore on Hainan Island on the evening of the 20th. Her intensity was estimated to be 70 kn. Meanwhile, the midlevel low over China had receded toward the north, and the subtropical ridge began to build westward, north of Sarah. During the next 6 hr the typhoon slowed to 8 kn and took a westward course, passing north of the central mountain range of Hainan. At 1800 Tan-Hsien (19.5°N, 109.6°E) was near the center and reported 15-kn winds from the east-northeast and a sea-level pressure of 969.5 mb.

Typhoon Sarah entered the Gulf of Tonkin on the 21st with an estimated 65-kn intensity. She accelerated to 15 kn and went ashore near Haiphong. The final warning on Sarah was issued at 1200 on the 21st as she was dissipating over the Red River Valley, northwest of Hanoi. Very little damage occurred during Sarah's existence. Only Hanoi radio reported cases of destruction with no casualties.

## THELMA

Thelma, the second typhoon of the 1977 season, wrought more destruction on Taiwan than any event since World War II. While typhoon Sarah was still crossing the South China Sea, Thelma was detected by satellite on July 20 as a tropical disturbance in the central Philippine Sea. The disturbance continued to organize during the next 24 hr, and the first warning was issued on the 21st at 0000.

Reconnaissance aircraft at 0918 on the 21st found flight-level winds of 55 kn, central pressure of 993 mb, and surface winds estimated at 50 kn. Based on aircraft data and corroborating satellite data the tropical depression was upgraded to tropical storm Thelma at 1200. During the following 30 hr, Thelma continued to intensify at a rate of 5 kn per 6 hr. At 2050 on the 22d, aircraft fixed the tropical storm 255 mi northeast of Manila and observed 60-kn winds at its 700-mb flight level. The aircraft further indicated that the central pressure had fallen to 965 mb. As a result of those observations, the system was upgraded to typhoon Thelma at 0000 on the 23d.

The trigger for Thelma's intensification was nearly identical to that of Sarah's a week earlier. Highly efficient outflow channels were provided Thelma by intense cyclonic cells in the upper air to the north and by strongly divergent upper level northeasterlies over Indonesia and the South China Sea to the south.

Thelma continued to move northwestward at 9 kn toward the southern periphery of the midtropospheric subtropical ridge. On the 23d the storm entered the Bashi Channel, passing 10 mi northeast of Escarpada Point on northeastern Luzon. At this time the KAKUHO MARU reported 80-kn winds and 20-ft seas just northwest of the center. On the 24th reconnaissance aircraft positioned Thelma 145 mi south-southwest of Kao-hsiung, which indicated that the storm was beginning to move northward. At this time the typhoon attained its maximum intensity of 85 kn with a minimum pressure of 957 mb and slowed to 6 kn. At 1800 the PRESIDENT MCKINLEY reported 45-kn winds and 20-ft seas while some 70 mi northeast of the eye.

On the 25th radar data showed that Thelma had turned to the north-northeast and had accelerated to 10 kn. During the early afternoon of the 25th Thelma crashed into Kao-hsiung harbor (fig. 14). The Chinese Weather Central reported that Kao-hsiung observed 86-kn peak winds accompanied by a 991.5 mb pressure minimum at 0939 local time. Satellite, aircraft, radar, and synoptic data all indicated that the typhoon was small, but very intense. Most damage was confined to the direct path of typhoon Thelma as the central mountain range of Taiwan drastically weakened the peripheral winds east of the typhoon's track.

After moving across southwestern Taiwan, Thelma

Figure 14.--Typhoon Thelma entering southwestern Taiwan with an 80-kn intensity at 0243 on July 25. DMSP Imagery.

began to weaken and moved on a track slightly west of north. On the evening of the 25th, she entered the Taiwan Straits, and on the following morning Thelma went ashore on mainland China, 30 mi north of Fu-Chou with 50-kn winds.

During her rampage over Taiwan, Thelma claimed more than 30 lives, injured thousands, and rendered an estimated 5,000 homeless. The typhoon ripped down 53 steel towers supporting high-tension powerlines. The loss of power closed more than half of the island's 45,000 factories. Taiwan's largest harbor at Kaohsiung was virtually destroyed. All eight giant cranes used to load and unload cargo were badly damaged or destroyed. At least 17 ships capsized in the harbor (fig. 15). In her few short hours over southern Taiwan, Thelma left destruction amounting to several millions of dollars. According to the Central Weather Bureau of Taiwan, typhoon Thelma was the most destructive tropical cyclone to hit Taiwan in more than 80 yr.

VERA

A tropical disturbance north of the climatologically favored area was first evident on satellite imagery and JTWC's synoptic gradient level analysis at 0000 on July 26 with a cyclonic surface circulation center near 25.5°N, 133.6°E. Exhibiting westward movement over the next 24-hr period, the disturbance gained organization and potential for significant development. By 1800 on the 27th the surface circulation reflected 30-kn winds at the surface, and JTWC's initial warning on the system as a tropical depression was issued at 0000 on the 28th. Subsequent poststorm analysis revealed that the depression had reached minimum tropical storm intensity (35 kn) by initial warning time.

Beginning as far back as the 22d, a low cell imbedded in a tropical upper tropospheric trough had formed to the northeast of the initial warning position. This cell tracked west-southwest and was centered near 30.5°N, 131°E, at 0000 on the 26th. The trough was now nearly east-west oriented, continued to dig toward the west and at the same time an upper level anticyclone over Korea and Japan built eastward. The 200-mb winds at stations along the east coast of Japan reflected 60 to 75 kn out of the north-northeast. By 1200 on the 27th the cell was centered near 27.8°N, 133.5°E, with strong diffluence southeast of the cell over the surface disturbance (fig. 16). The vertical

Figure 15.--The battered 3,000-ton oil tanker CHENG LUNG lies on her side as a result of typhoon Thelma's assault on the port of Kaohsiung. United Press International Photo.

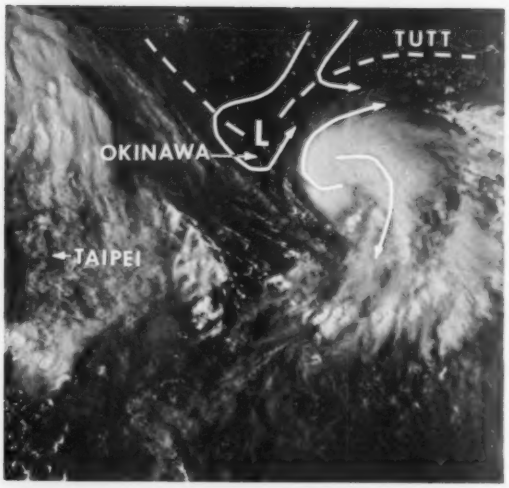


Figure 16.--Vera at barely 40-kn intensity showing strong diffluence aloft to the southeast of a LOW. NOAA-5 Imagery.

coupling had thus been effected, and the necessary conditions for tropical-cyclone development fulfilled.

At 0000 on the 28th the depression was upgraded to tropical storm Vera. A generally westward track (260°) at 3 kn was observed. Steering at this point seemed to be governed by the easterly flow on the southern periphery of the major anticyclone over Korea and Japan. By 1200 on the 29th the anticyclone began to build toward the southwest in advance of Vera. As she proceeded southwestward, Vera continued to intensify attaining 65 kn by 1200 on the 29th. By 1800 Vera had intensified to 90 kn proceeding to the southwest at 9 kn. After 1800 a marked decrease in forward speed was noted (from 9 to 4 kn) as the northeasterly steering at upper levels appeared to relax. Simultaneously, an increase in intensity occurred. By 0600 on the 30th Vera's winds were 100 kn, and satellite imagery revealed a well-defined eye (fig. 17), while reconnaissance aircraft reported 100 kn at the 700-mb flight level. By 1200 satellite data showed improved outflow channels aloft to the west and north, and fix positions supported a more west-northwestward track.

Upon making her turn to the west-northwest, it became evident that Vera would likely pass directly over Iriomote-Jima and just to the south of Ishigaki-Jima. Figure 18 shows the hourly surface reports from Ishigaki-Jima and indicates eye passage south of the island

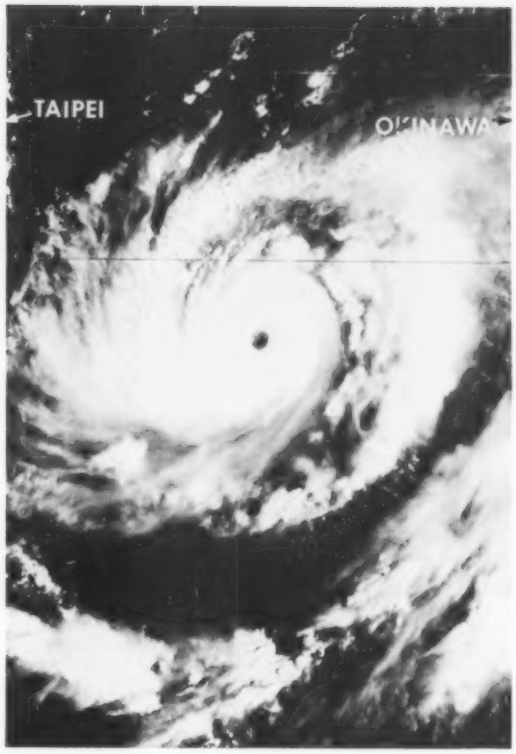


Figure 17.--Typhoon Vera 200 mi east of Taiwan and accelerating northwestward.

between 2100 and 2200 on the 30th. Maximum winds were from the southeast at 103 kn at 2200 (fig. 19). Minimum pressure was 935.6 mb at 2100. As Vera passed south of Ishigaki-Jima, her speed had increased to 10 kn. Postanalysis revealed that Vera attained her maximum intensity of 110 kn at 0000 on the 31st and decreased in intensity slowly thereafter as she approached Taiwan at a speed of 11 kn (fig. 20).

Landfall occurred on the island of Taiwan at the mouth of the Chi-Lung Ho River basin. Vera followed the river basin to the west-southwest toward Taipei. Keelung recorded a minimum low pressure of 939.9 mb at 0930 on the 31st and a total rainfall of 7.95 in. Maximum winds recorded at the Weather Bureau office in downtown Keelung were 66.6 kn with gusts to 113 kn at 1030. In Taipei a minimum pressure of 951.5 mb was

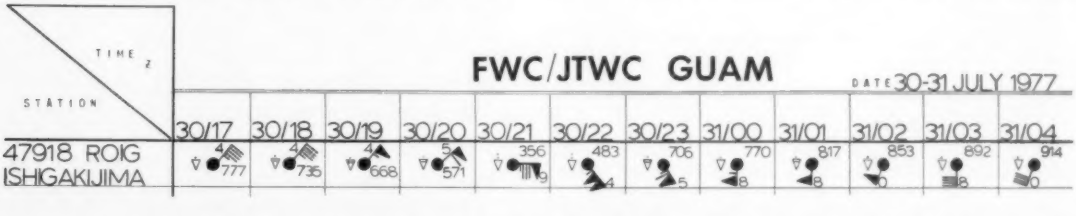


Figure 18.--Hourly surface synoptic observations from Ishigaki-Jima during passage of typhoon Vera.

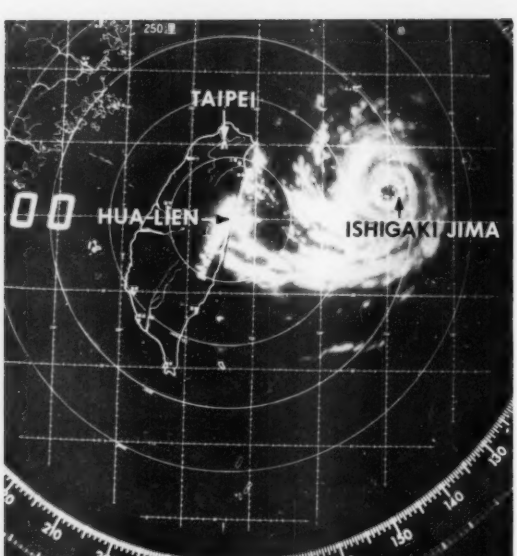


Figure 19.--Hua-Lien radar presentation of typhoon Vera when Ishigaki-Jima was receiving maximum sustained winds of 103 kn at 2200 on July 30. Photo courtesy of Central Weather Bureau, Taipei, Taiwan, Republic of China.

recorded at 1028 on the 31st with total rainfall of 8 in. Taipei International Airport reported maximum winds of 64 kn with gusts to 96 kn. Both Keelung and Taipei established new records in observed maximum wind reports with Vera's passage. After passing over the northeastern part of Taipei City, Vera continued on a nearly westward track and emerged in the Taiwan Straits just north of Hsin Chu at 1500 on the 31st (fig. 21). Vera continued on a westward track and made landfall on the China mainland near Ch'uan-Chou at 0100 on August 1 with an intensity of 80 kn.

Following so closely after typhoon Thelma, which had wreaked havoc on the southern portion of Taiwan, typhoon Vera left at least 25 dead in her wake and vast amounts of property and crop damage (fig. 22). Two ships sank, 10 went aground, 3 were washed away, and 22 were damaged. However, with timely warnings and the occurrence of Thelma 2 weeks earlier, most ships diverted and rode out the storm in the safety of the open sea.

## BABE

No typhoons were observed during August. The JTWC significant Tropical Weather Advisory of August 31 stated, "The probability is that the remainder of 1977 should see an increase in typhoon activity." The next day (September 1) the seedling of the year's 10th tropical cyclone and the only supertyphoon was first observed. Babe was a very challenging storm in that during her lifetime she threatened virtually every major Department of Defense facility in the western North Pacific.

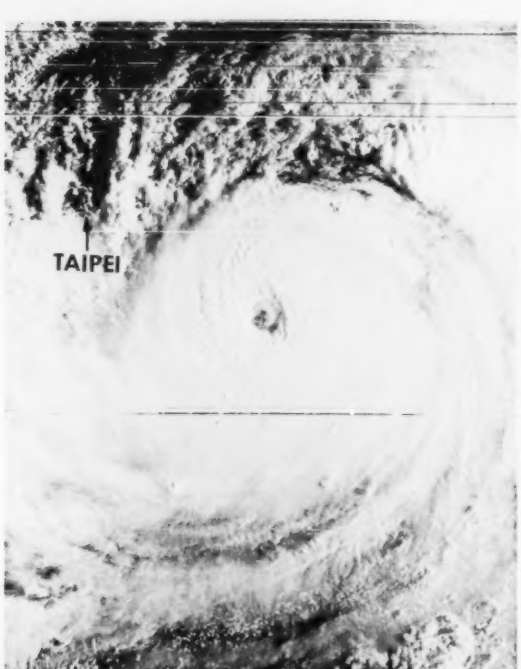


Figure 20.--Typhoon Vera at maximum 110-kn intensity and just 19 min after the radar imagery in figure 19, 2219 July 30. (DMSP Imagery)

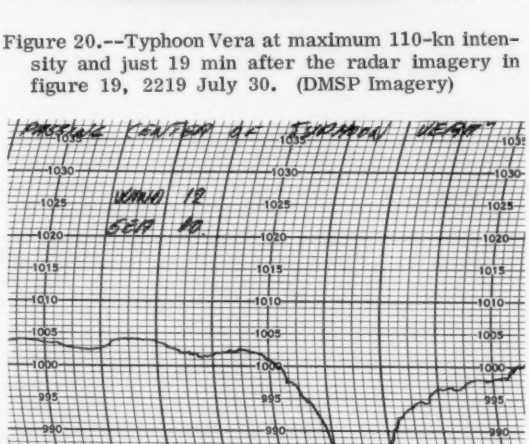

Figure 21.--Barogram of the ARTHUR MAERSK showing 972 mb at 1330 July 31 near 25°N, 120.7°E, as the ship passed close to the center of typhoon Vera.

Figure 22.--These powerline posts along a thoroughfare in downtown Taipei are alined like fallen wooden soldiers. They must have all fallen at the same time as the lines are straight and some are not even broken. Wide World Photo.

Satellite and synoptic data on the 1st indicated a weak surface circulation with associated convection near 7°N, 150°E, and a Tropical Cyclone Formation Alert was issued. The first warning of a tropical depression was issued at 0000 on the 2d. An aircraft fix at 0052 estimated maximum surface winds at 40 kn. The depression was upgraded to tropical storm Babe at 0600.

Babe slowly intensified as she moved westward across the warm Philippine Sea. She was being steered at this time by a well-developed midtropospheric subtropical ridge which extended from the dateline into central China. With this westward movement expected to continue, Babe was forecast to cross the Republic of the Philippines and pose a threat to Subic Bay and Clark Air Base. Westward movement continued until early on the 5th. Between the 2d and the 4th, Babe had an average speed of 14 kn. By the 4th at 1200 the speed had dropped to 8 kn, further dropping to 5 kn in the following 12 hr.

On the 5th at 0000 an upper air trough in the midlatitude westerlies appeared over northeastern Asia. A weakness in the subtropical ridge between the trough and Babe became evident and increased the probability of a more northerly storm track. A change in Babe's direction of movement was first noted by satellite data at 2155 on the 5th and confirmed by aircraft reconnaissance at 2243.

Taiwan, which was still recovering from the effects of typhoons Thelma and Vera, was now threatened again. Aircraft data between the 5th and the 7th showed Babe had undergone rapid deepening with the central pressure dropping from 988 mb to 907 mb, a rate of 1.3 mb/hr. This rapid deepening was in response to the divergent southwesterly flow ahead of a strong upper air trough now stretching from east of Japan into central Taiwan which provided a strong outflow channel aloft. Babe was upgraded to a typhoon on the 6th at 0000 and a supertyphoon on the 8th at 0000 (fig. 23).

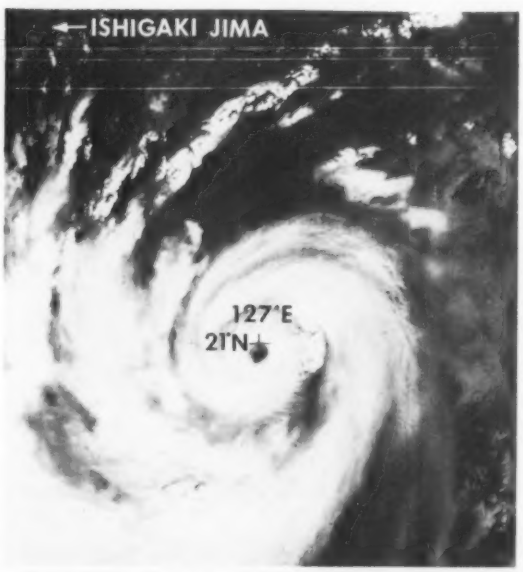


Figure 23.--Supertyphoon Babe at 130-kn intensity 250 mi southeast of Ishigaki Jima at 0303 on September 8. (DMSP Imagery)

Up until the 8th Babe was forecast to cross Taiwan and then dissipate in mainland China prior to full recurvature. On the 7th at 1200, however, another upper air trough moved into northern China. This short wave additionally weakened the midtropospheric ridge over southeastern China. A low soon developed in this trough over Korea indicating the trough would move slowly and possibly deepen. This increased the probability that Babe would recurve much earlier than expected. This came to pass and as Taiwan was relieved, Okinawa and Japan now faced the fury of Babe. Aircraft and radar data showed Babe began recurvature to the northeast after the 8th at 0600 while weakening at a rate of 5 kn/6 hr. Conditions of readiness were set for southern Japan, and aircraft evacuated Kadena Air Base for appropriate "safe havens."

During Babe's north-northeastward transit, the upper air low which had formed over Korea moved south-southwestward, deepened, and cutoff from the main upper air trough. Evidence of a Fujiwhara-type effect between Babe's circulation and the cutoff low also appeared. Babe finally steered around the northern periphery of the cutoff low and hit the People's Republic of China just north of Shanghai on the 11th at 0000 with surface winds of 65 kn (fig. 24).

The greatest damage from supertyphoon Babe occurred after she recurved and headed for Japan. Newspaper reports described Babe as "the worst typhoon to threaten Japan in 18 years." Babe struck the Japanese island of Okino-Erabu with winds of 135 kn injuring 45 people and destroying 1,600 homes. Kadena Air Base recorded maximum sustained winds of 36 kn on the 9th and a peak gust of 60 kn at 1328. Babe also disrupted maritime activities sinking a Panamanian freighter with 16 reported dead or missing and damaging approximately 100 Japanese fishing vessels which sought safety in the East China Sea.

## DINAH

Dinah, the fifth typhoon of 1977, displayed the most unusual behavior. While over the South China Sea, the storm executed two hairpin turns and one loop before meandering over Southeast Asia during dissipation. Dinah's development, however, was a more normal sequence of events.

Supertyphoon Babe's extensive circulation system aided the monsoon trough to move north of its normal location. After Babe dissipated over eastern China, the monsoon trough extended from Southeast Asia to the Mariana Islands along latitude 20°N. South of the trough, deep southwesterly flow produced local gale-force winds and extensive areas of thundershowers. North of the trough, steady easterlies prevailed. Although the opposing currents produced considerable cyclonic shear and relative vorticity within the trough, the counter-productive northeasterlies in the upper troposphere produced enough vertical shear to prevent significant tropical-cyclone development. Meteorological satellite data during the second week of September showed several loosely organized areas of convection within the monsoon trough. On the 12th synoptic data located a low-level circulation center 400 mi to the north of Guam. Maximum intensity near the center was estimated to be 20 kn, while local gale-force winds continued within the southwest monsoon current to the southern and eastern periphery of the monsoon trough. (Islanders in the southwest flow could not believe there was not a tropical storm or typhoon nearby.)

The circulation center initially moved northwestward at an average speed of 16 kn. Satellite data soon identified a distinct vortex which separated from the areas of southwest monsoon cloudiness. The disturbance now moved westward as it entered the steering influence of an anticyclone over the East China Sea. Satellite pictures showed larger and better developed banding features. Corresponding surface reports also indicated intensification. Postanalysis, however, found that the disturbance had achieved tropical depression intensity by 1800 on the 13th and tropical-storm stage by 0000 on the 14th (fig. 25). Because of fav-

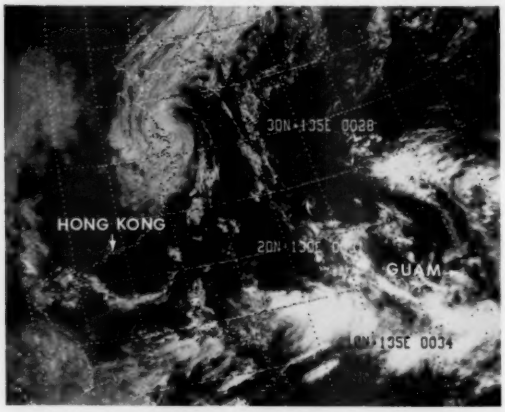


Figure 24.--Typhoon Babe during landfall 60 mi north of Shanghai, People's Republic of China, September 11 at 0109. The monsoon trough extending from the Philippine to the Mariana Islands would soon spawn the next typhoon, Dinah. (NOAA-5 Imagery)

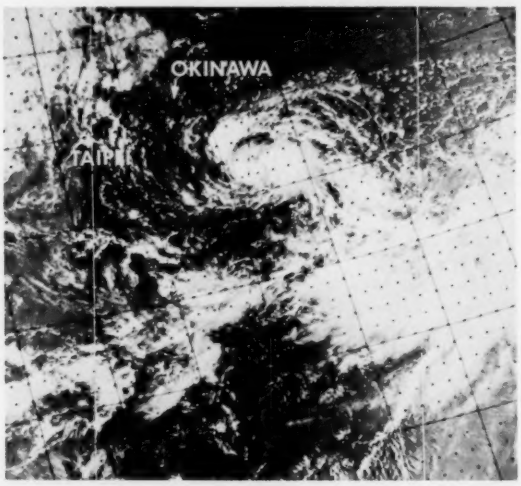


Figure 25.--Dinah at tropical-storm stage intensifying in an interesting split configuration on September 14 at 0023. (NOAA-5 Imagery)

orable conditions present during this time, another disturbance about 300 mi north of Guam developed into tropical storm Emma.

On becoming tropical storm Dinah, the pressure gradient between the storm and the subtropical ridge increased. The associated easterly steering currents correspondingly increased and accelerated Dinah to a maximum speed of 19 kn. An intensifying, midtropospheric high over eastern China was now the primary source of these easterlies. As this high-pressure cell continued to build, Dinah moved southwestward toward the Republic of the Philippines. Her forward speed decreased as the gradient slackened. Steady intensification continued as upper level outflow was well established in all quadrants. This trend persisted until Dinah reached minimum typhoon strength at 0600 on the 15th just 100 mi off northern Luzon. With a maximum intensity of 55 kn the storm entered Luzon 35 mi south of Escarpada Point at 1500. That evening Dinah passed near Tuguegarao, a station in northeastern Luzon, which experienced 96-kn peak winds and a mean sea-level pressure of 977 mb.

After 7 hr over land, Dinah entered the South China Sea and weakened to 40 kn, but reintensified to 50 kn during the next 14 hr. Headed west-southwestward, Dinah entered an area of weaker steering currents. The dominating anticyclone over China was beginning to weaken and midlatitude westerlies began extending southward. By the 17th the continued weakening of steering currents caused the storm to slow.

For the next 4 days Dinah exhibited unusual behavior. The weakening subtropical ridge over China broke down into a series of smaller high cells, while the southwest monsoon deepened. Caught between these oscillating and opposing steering sources, Dinah abruptly turned northeastward and then executed a loop during the 17th. As the southwest monsoon strengthened and became the dominant steering flow, the storm was directed northeastward toward Taiwan.

Intensification resumed as a result of the enhanced monsoon. The weakening subtropical ridge and increasing outflow aloft also contributed to Dinah's growth. By 1800 on the 18th typhoon strength was achieved again. By the 19th an advancing midlatitude trough over China aided in steering Dinah eastward. Sustained winds of 65 kn persisted as satellite imagery revealed an eye. At 0000 on the 20th, Dinah reached a short-lived maximum intensity of 75 kn (fig. 26). Ever since Dinah's origin, the southwest monsoon was the major feeding current. This flow was now being diverted into the beginnings of tropical storm Freda in the Philippine Sea and Dinah began to weaken.

As a midlatitude trough advanced over China, a large high-pressure area built behind it. In response, Dinah slowed, turned westward, then southwestward under the influence of the intensifying high over China. Dinah was the first storm to be directly affected by an early autumn surge in the northeast monsoon. Northeasterlies from the strong high over China controlled Dinah's movement for the next 2 days. Diminishing, moist southwesterlies and increasing, dry northeasterlies steadily weakened the storm. Dinah accelerated southwestward and reached south Vietnam as a weak tropical depression.

After landfall, Dinah, in its dissipating stage, persisted for 4 days. Tropical storm Freda and the weakening of the northeast monsoon were the controlling

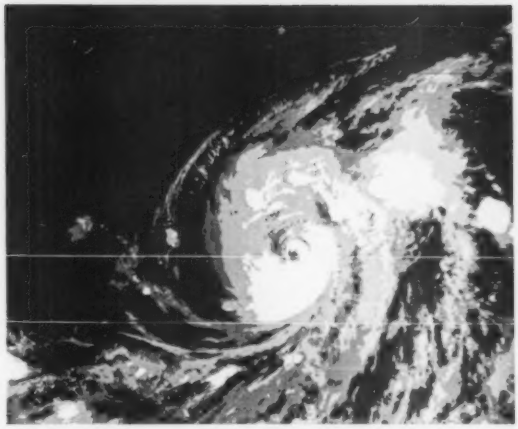

Figure 26.--Infrared, threshold photograph of typhoon Dinah at maximum intensity of 75 kn on September 19 at 2310. This special product consolidates the thermal range into four slices (gray shades) with white being coldest and black warmest. (DMSP Imagery)

agents in the last days of Dinah's unusual track. After crossing the South China Sea, Freda entered southern China drawing the southwest monsoon northward. Once again embedded in a southwest steering current, Dinah journeyed northward through Cambodia, northeastward over the Gulf of Tonkin, then northward into southern China and finally dissipated.

Dinah's sweep across northern Luzon caused loss of lives and property. Floods and landslides caused 15 deaths and 11 missing. Although Dinah remained a safe distance from mainland China while jogging unpredictably over the South China Sea, Hong Kong displayed the Stand By Signal No. 1 for a record 124 hr and 40 min.

## GILDA

On October 1 a large area of heavy convection 300 mi in diameter was detected approximately 325 mi north of Ponape. Synoptic data indicated a weak surface circulation in the vicinity. The system was moving northward toward a weakness in the midtropospheric subtropical ridge. Aircraft reconnaissance on the 3d reported 38-kn winds at the 1,500-ft flight level. Based on this data and the assessed good potential for further intensification, the first warning was issued at 0000 on the 3d.

For the next 18 hr the tropical depression moved erratically toward the north. The midtropospheric subtropical ridge to the northeast began to build to the west. Divergent southwesterlies aloft, on the southeast periphery of the upper level cyclonic cell, enhanced the outflow, and by 1800 on the 3d the system had reached tropical-storm intensity.

Tropical storm Gilda continued to intensify on the 4th as she accelerated to 12 kn on a northwestward track. Reconnaissance aircraft on the 5th indicated 80-kn winds at the 700-mb flight level and observed that the central pressure had fallen to 974 mb, a 15-mb drop in 11.5 hr. Gilda was upgraded to a typhoon at 0600.

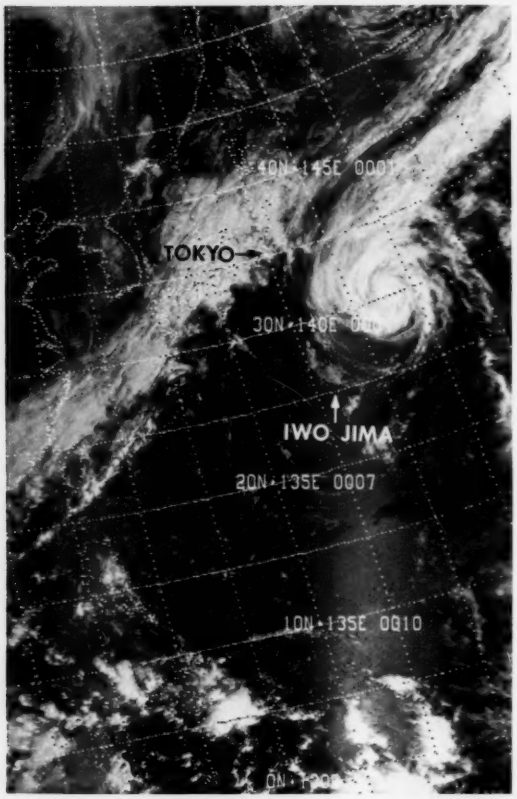


Figure 27.--Typhoon Gilda at maximum intensity of 70 kn during recurvature on October 7 at 2343. (NOAA-5 Imagery)

A midtropospheric, short-wave trough had moved eastward from eastern China toward Japan and began to deepen. By the 5th this trough had moved east of northern Japan and had dug sufficiently equatorward to sever the subtropical ridge north of Gilda. By the 6th the typhoon had acquired a north-northwestward track toward the weakness in the ridge. Aircraft reconnaissance showed that the central pressure had risen to 986 mb; consequently, Gilda was downgraded to a tropical storm. This weakening, however, was short-lived; 24 hr later she again attained typhoon intensity. On the 7th Gilda passed through the weakness in the subtropical ridge and shortly thereafter began recurving toward the north-northeast. As is frequently observed with October tropical cyclones, typhoon Gilda continued to intensify after recurvature. She attained peak intensity of 70 kn on the 8th when aircraft reported a minimum sea-level pressure of 968 mb (fig. 27).

By nighttime on the 8th, Gilda had again weakened to tropical-storm strength. During the next 36 hr the storm accelerated rapidly toward the east-northeast. On the morning of the 10th, Gilda became extratropical, moving toward the east-northeast at more than 30 kn.

During her 8-day span, the closest point of approach to land was 220 mi southwest of Marcus Island on the evening of October 5. On the ocean ships stayed well away from Gilda's strong winds. As a result, Gilda claimed no loss of life or damage to property.

## IVY

Ivy, the seventh typhoon of 1977, originated from an easterly wave. She was first detected by synoptic data moving westward over the Marshall Islands on October 14. Within 24 hr the storm entered an area of increased low-level convergence associated with the near equatorial trough (NET), intensified, and developed a surface circulation. Ivy's development was also aided by the movement of tropical storm Harriet, which was also embedded in the NET. Harriet moved northward through the Philippine Sea displacing the NET northward. This northward shift allowed for an increase in favorable conditions for intensification. By the 19th the developing cyclone (Ivy) was receiving most of the low-level, southwesterly flow that was previously supplied to the now weakening Harriet. The next day satellite data indicated that the disturbance's convective activity and organization had increased, while surface reports indicated that the central pressures were steadily falling.

Upper tropospheric synoptic data on the morning of the 21st indicated that the outflow pattern above the alert area was continuing to strengthen. Aerial reconnaissance detected an organized surface cyclonic circulation with a 996-mb central pressure. Reconnaissance data further indicated that the disturbance was moving northward just east of the Mariana Islands.

On the morning of the 20th the depression began moving through a break in the subtropical ridge previously opened by Harriet. This was also an area of weak and variable steering currents. From the 21st

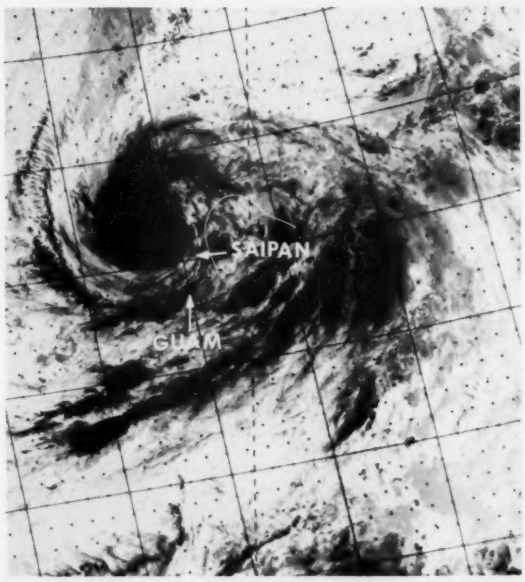


Figure 28.--Infrared photograph of Ivy with 40-kn winds executing a cyclonic loop on October 22 at 0923. (DMSP Imagery)

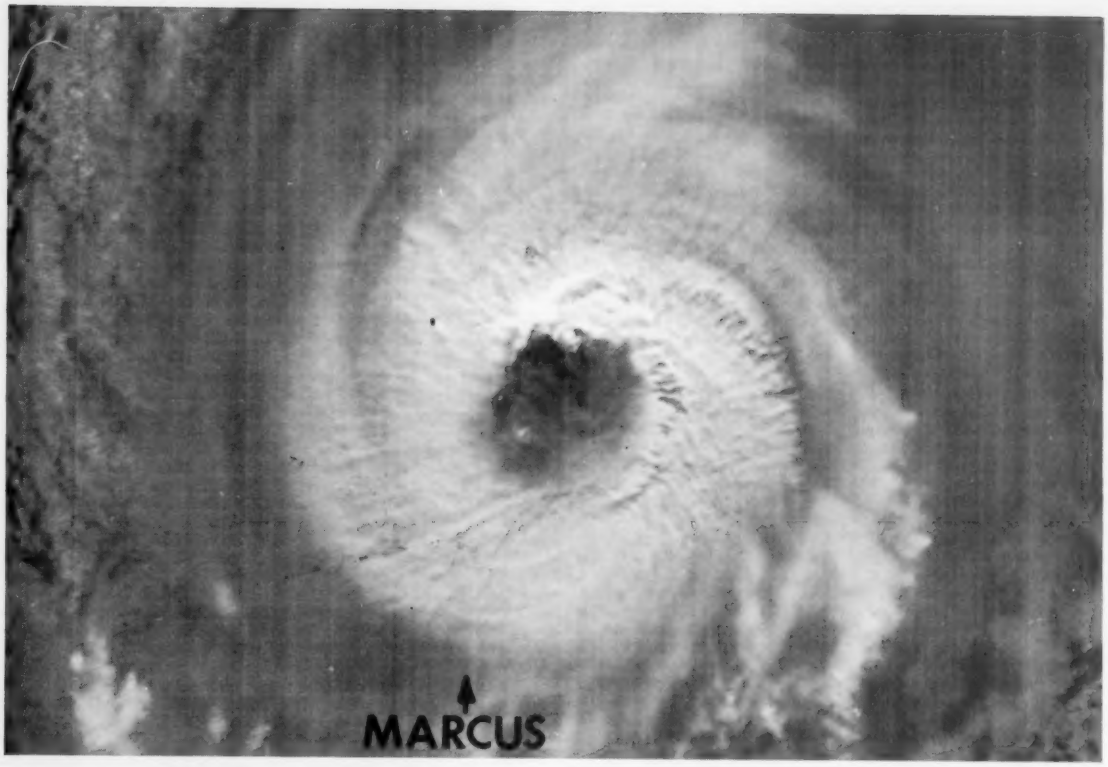


Figure 29.--Typhoon Ivy displaying a well-defined eye at its maximum intensity of 90 kn at 0106 on October 25. (DMSP Imagery)

to the evening of the 22d there was a lack of any definitive, middle-tropospheric steering flow which resulted in erratic movement of the storm. For 36 hr Ivy meandered and then looped before heading northeastward (fig. 28) as a tropical storm. Aircraft reconnaissance on the 21st observed maximum flight-level 700-mb winds of 38 kn associated with the storm.

From the evening of the 22d the storm began to accelerate and move northeastward in response to an eastward-moving, short-wave trough in the midlatitude westerlies. This created an upper air regime which was favorable for further intensification. On the morning of the 24th Ivy reached typhoon intensity. Reconnaissance aircraft recorded a central pressure of 967 mb and observed sustained 700-mb winds of 75 kn about an eye 30 mi in diameter.

Ivy continued moving northeastward and passed 20 mi northwest of Marcus Island on the 24th. Marcus reported sustained 70-kn winds at 1800 and 111-kn gusts at 2100. As Ivy continued northeastward, further intensification took place. A maximum strength of 90 kn was reached on the 25th (fig. 29). New aircraft data reported a well-defined eye with a 945-mb central pressure. Typhoon Ivy maintained maximum intensity for 12 hr. The continued northward displacement was due to the increasing influence of a quasi-stationary, upper level trough east of Japan. This also caused the storm to enter a cooler environment which began to degrade Ivy into an extratropical system. The last warning was issued at 1800 on the 26th. Ivy quickly weakened and became extratropical along a cold front.

## JEAN

Tropical cyclone Jean established two season records: first, as the shortest lived typhoon of the season; and second, as the only tropical cyclone of 1977 for which a formation alert was not issued prior to the initial warning. Jean was first observed as a weak disturbance some 200 mi southeast of Kwajalein Atoll on October 24. While moving northwestward, the disturbance was included on JTWC's Significant Tropical Weather Advisory for the next several days. The disturbance was located downstream of an upper tropospheric trough axis in a diffluent area aloft, a favored position for development. By 1200 on the 27th an upper tropospheric outflow center (200 mb) was analyzed over the surface position, further supporting development.

Due to the presence of a ship in close proximity to the cyclone, the initial warning on the tropical depression was issued at 1200 on the 28th with an intensity of 30 kn and a northwesterly movement at 14 kn. Satellite data over the next 6 to 12 hours showed an increase in intensity, and at 1800 the depression was upgraded to tropical-storm status. At this same time Jean was beginning to show a more northward trend and had slowed

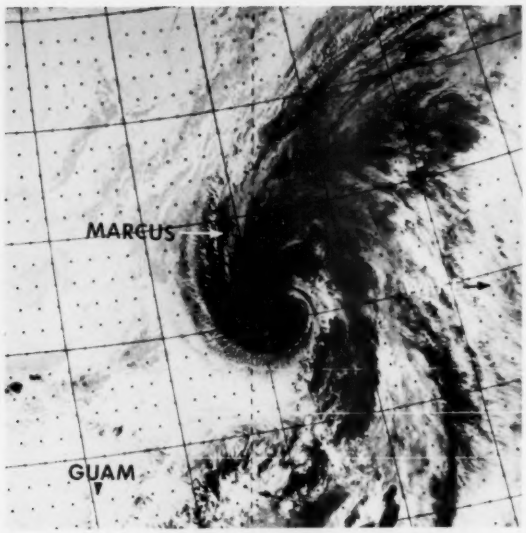


Figure 30.--Infrared photograph of Jean at 55-kn intensity tracking north-northeastward on October 29 at 0905. (DMSP Imagery)

appreciably to a speed of 6 kn. The more northward thence north-northeastward track was attributed to upper and midtropospheric level steering influences which were dominant above the easterly steering flow near the surface and in the lower troposphere.

On the 29th reconnaissance aircraft penetrated the storm and observed surface winds near 60 kn and also reported that an eye was beginning to form. Satellite imagery at 0905 (fig. 30) further supported the observed intensification; consequently, at 1800 on the 29th Jean was upgraded to a typhoon. Satellite positioning also dictated a more north-northeastward track. Jean maintained minimum typhoon intensity for only the next 6 hr, thereby establishing the aforementioned record as the shortest lived typhoon of the season.

Postanalysis revealed that beyond the 0000 position of Jean on the 30th she began to react to the effects of very strong vertical shear. At the surface and at low tropospheric levels, steering flow was strong easterly around the southern periphery of the subtropical ridge. Under this hostile regime, Jean began to weaken and had made her furthest northeastward incursion by 1200 on the 30th at an intensity of 55 kn. Satellite data showed an exposed low-level circulation center to the west of the area of major convective activity. Jean began to weaken rapidly and moved west and then west-northwestward in response to the east/east-southeasterly steering at low tropospheric levels. Figure 31 is a graphic depiction of Jean's passage north of Marcus Island through 3-hr synoptic reports.

The final warning was issued at 1200 on the 31st with dissipation forecast within 12 hr. The low-level circulation was closely monitored by satellite for signs of reintensification for the next 24 to 36 hr. By November 1 the disturbance began to show an improved satellite signature with an increase in convective activity, and a warning was issued again at 0000 on the 2d. At this time the depression was meandering northward and showed an intensity of 30 kn. For the next 12 to 24 hr, the system executed a looping movement, and by 1450 satellite data again showed the effects of strong vertical shear with an exposed low-level circulation visible to the west of the main convection. Once sheared off, the low-level circulation responded to low tropospheric northeasterly flow around the southeastern periphery of a large anticyclone centered over the Sea of Japan. The low-level circulation center continued tracking to the southwest and then west-southwest, remaining weak but visible on satellite imagery until early on the 6th.

## KIM

Kim originated in an active near-equatorial trough which extended through the western Marshall Islands. Weak surface circulations existed within this trough near Ponape and Kwajalein. On November 2 this activity consolidated into a single surface circulation 100 mi southwest of Ponape with a central pressure of 1007 mb. The disturbance began moving northwestward within the NET at approximately 6 kn.

On the 3d a circulation center was about 150 mi to the northwest of Ponape. Aircraft reconnaissance on the 5th found a central pressure of 1007 mb and estimated maximum surface winds at 20 kn. A second aircraft investigation on the 6th fixed the system with a 1004-mb central pressure and maximum surface winds of about 25 kn. The first warning was issued at 0600 on the 6th, and the system was upgraded to tropical storm Kim just 12 hr later.

Kim turned toward Guam at a speed of approximately 10 kn. Slow intensification occurred during the next 48 hr due to the dominance of a strong subtropical ridge to the north. A short-wave trough in the upper tropospheric westerlies also hampered rapid development by restricting outflow to the north of Kim. However, after the trough passed, outflow aloft steadily strengthened. A deepening long-wave trough over

FWC/JTWC GUAM DATE 30 OCT 1977

| TIME Z / STATION | 30/21 | 31/00 | 31/03 | 31/06 | 31/09 | 31/12 | 31/15 | 31/18 | 31/21 | 01/00 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
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Figure 31.--Three-hourly synoptic surface observations at Marcus Island during the passage of Jean.

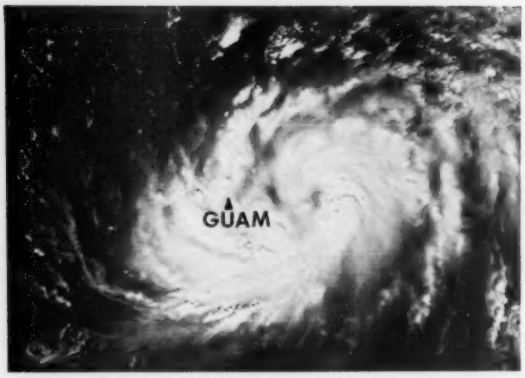


Figure 32.--Kim at 50-kn intensity, rapidly intensifying, and heading for Guam, November 8 at 0204. (DMSP Imagery)

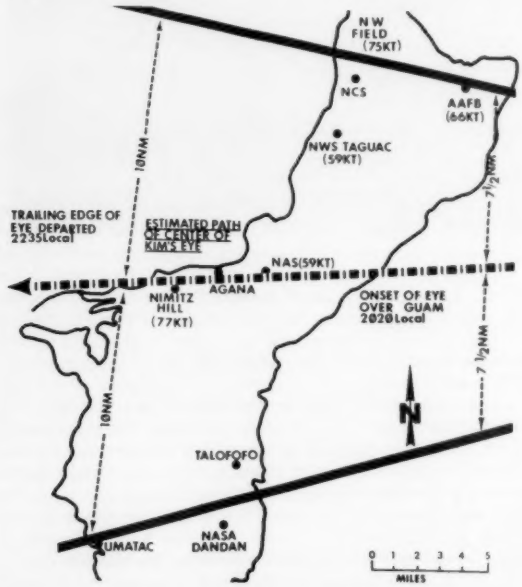


Figure 33.--Track of Kim's passage over Guam.

eastern Asia was now beginning to weaken the subtropical ridge which had previously suppressed Kim's low-level development. Satellite data on the 8th indicated increased organization (fig. 32). Kim began to intensify at a rate of 30 kn in 24 hr, and the central pressure dropped 22 mb in a 24-hr period.

Kim passed directly over Guam on the 8th between 1020 and 1235 approaching from the east-southeast, moving westward over the island, and exiting toward the west-northwest (fig. 33). The eye entered with a circular configuration and exited with an elliptical configuration. The duration of the eye passage over the island lasted up to 1 hr and 10 min near the center of the storm track. The peak gust recorded was 77 kn on Nimitz Hill. The greatest damage was in the southern end of the island where 22 homes were damaged or destroyed (figs. 34 and 35). Fortunately, no lives were lost on Guam.

Kim was upgraded to typhoon strength at 2200 local time on the 8th just after exiting Guam. For the next 48 hr the storm continued to intensify. The subtropical ridge continued to slowly weaken throughout this period, but it maintained sufficient strength to steer Kim in a west-northwestward direction. Kim advanced toward another weakness in the ridge between two subtropical high-pressure cells. As the tropospheric steering flow weakened, forward speed decreased and intensification increased. When Kim was nearest this weakness within the ridge, she attained a maximum intensity of 125 kn (fig. 36).

Kim was soon headed straight for central Luzon. Landfall occurred on the 13th causing extensive damage on the coastline with winds of 115 kn. The storm

Figure 34.--Kim's nearly typhoon-strength winds battered the exposed coastal village of Umatac. Photo courtesy of P.J. Ryan of the Pacific Daily News.

Figure 35.--Although damage was slight on most of the island, Umatac Village on the southwest coast did not fare so well. Photo courtesy of P.J. Ryan of the Pacific Daily News.

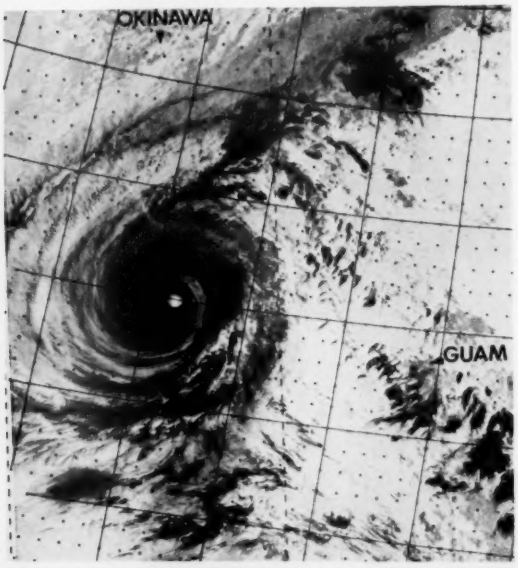


Figure 36.--Infrared photograph of typhoon Kim at peak intensity of 125 kn on November 10 at 2145. (DMSP Imagery)

passed about 35 mi north of Manila and 5 mi south of Clark Air Base.

The typhoon exited into the South China Sea 7 hr after landfall with an intensity of 65 kn. This amount of weakening is in good agreement with the latest climatological studies of intense typhoons crossing Luzon. Even though the South China Sea had warm sea-surface temperatures, Kim never reintensified due to strong, cool northeast monsoon flow entraining into the storm environment. Rapidly decelerating, Kim turned northward. Kim became an extratropical system by the 17th and merged with a weak frontal system east of Taiwan.

Kim was a long-lived storm with 44 warnings during a 12-day period. Guam sustained moderate property damage when Kim crossed the island as a strong tropical storm. Luzon, however, reported 55 drownings due to widespread flooding. In Manila a fire in a hotel, caused by a lighted candle, during the height of the storm resulted in 47 deaths. Minor damage occurred at Clark Air Base with a roof blown from a school building and falling trees causing other damage. One ship sank, while another went aground as Kim exited into the South China Sea.

## LUCY

Lucy was in most respects a typical winter-season storm. Development was difficult and near the Equator, while recurvature occurred at a low latitude. An un-

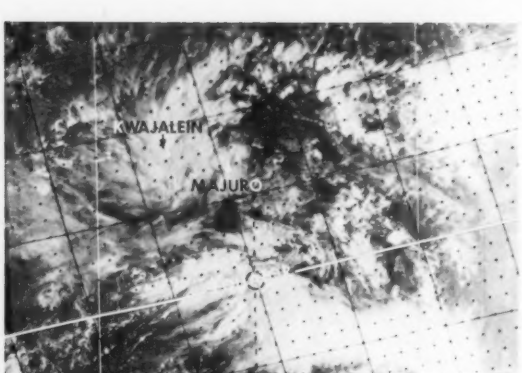


Figure 37.--"Double Vortices." Lucy is seen in her formative stage in the Northern Hemisphere between Kwajalein and Majuro, while Steve is near maturity in the Southern Hemisphere on November 25 at 2118. (NOAA-5 Imagery)

usual event happened during the development stage when the system divided into two disturbances and then recombined 2 days later.

As with the previous typhoon (Kim), Lucy's birth was a "double-vortice" development pattern. In this particular case a tropical cyclone in the Southern Hemisphere near-equatorial trough developed first and was well on its way to maturity before Lucy formed in the Northern Hemisphere NET. The expanding circulation about the Southern Hemisphere tropical cyclone (Steve) strengthened the westerly flow along the Equator, increasing the horizontal shear along the Northern Hemisphere NET and aiding the development of Lucy (fig. 37). On November 26, 33-kn gradient-level winds were observed at Tarawa, an island about 75 mi north of the Equator. Westerlies extended above 500 mb and created an extensive horizontal wind shear trough north of the Equator. Enough cyclonic spin was imparted over the Marshall Island area that the nearby preexisting disturbance began to develop.

A large midtropospheric anticyclone dominated the subtropical western Pacific and concentrated strong trade winds north of the depression. Synoptic data indicated an increase in circulation size and satellite imagery showed better organization. Weather reconnaissance aircraft were sent in to investigate further. Early on the 28th aircraft found a 997-mb surface pressure center with 30-kn surface winds and 45-kn flight-level winds at 1,500 ft. At 1200 on the 28th the depression crossed the southern coast of Ponape with only 10-kn sustained winds and 25-kn gusts.

On the 29th the depression split into two disturbances. One went northwestward, and the other west-southwestward around the Truk Islands. This split occurred when increasing amplitudes in the midlatitude long-wave patterns strengthened the subtropical, midtropospheric anticyclone which was positioned to the north. The pressure gradient generated 45-kn easterly flow at 500 mb. The resulting intense, horizontal shear produced enough vorticity to induce a secondary circulation system to the north. As they separated, both systems weakened as their energy sources also became divided. As the dual system moved westward away from the dominating influence of the subtropical high, horizontal shear and induced vorticity diminished. This resulted in the northern system's deceleration and dissipation. The primary southern system soon caught up and absorbed the remnants of the northern system 100 mi northwest of Woleai Atoll. By 0000 on December 1, the tropical depression was again a single system with the same intensity as before the split. The depression became tropical storm Lucy at 0600. Aircraft data, however, still indicated that the storm was best developed in the middle layers.

Lucy headed for the Republic of the Philippines, attained typhoon intensity at 0600 on the 2d, and continued to deepen. Synoptic and satellite data showed excellent upper level divergence in all quadrants. Aircraft reconnaissance began reporting maximum winds nearer the surface, indicating better vertical development. At this time Lucy attained a maximum intensification rate of 20 kn per 6 hr, and satellite data revealed a large, well-defined eye (fig. 38).

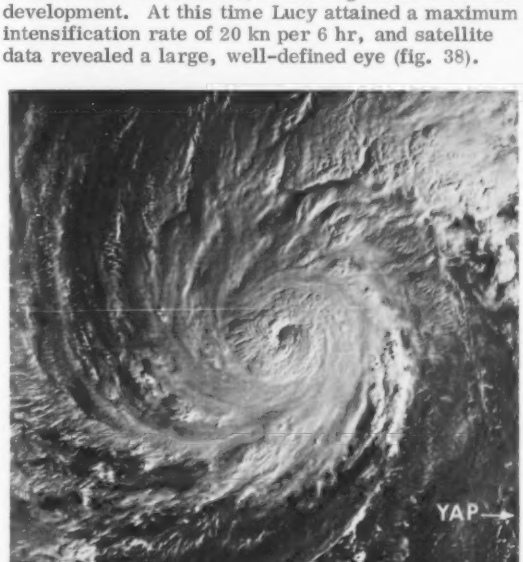


Figure 38.--Typhoon Lucy with 85-kn winds at 2215 on December 2 and undergoing rapid deepening. (DMSP Imagery)

By December 3 Lucy was again heading northwestward. At 1800 a 115-kn maximum intensity was reached. Within the next 12 hr, Lucy recurved ahead of an approaching trough. The storm soon became completely embedded in midlatitude westerly flow and accelerated northeastward. Lucy was downgraded to tropical-storm stage 48 hr after recurvature. Upper level vertical shear and low-level cool, dry entrainment became the significant factors for weakening. Lucy was eventually steered into a frontal zone and became an extratropical wave within the boundary.

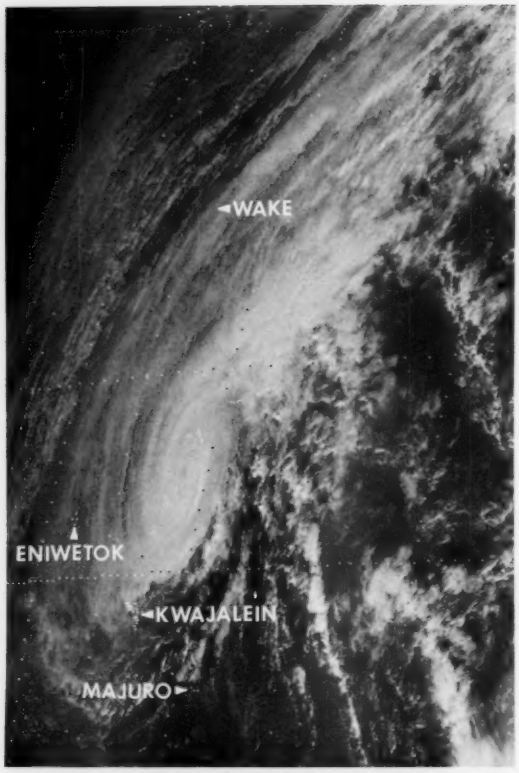


Figure 39.--Typhoon Mary during execution of a loop 6 hr before attaining a maximum 100-kn intensity, December 24 at 2049. (GOES Imagery)

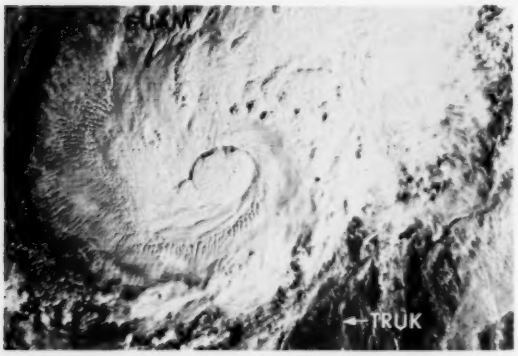


Figure 40.--Mary at 50-kn intensity and slowly deepening between Guam and Truk, 2136 December 28. (DMSP Imagery)

MARY

Mary, the 11th and final typhoon of the year, moved across the western Pacific for 15 days and covered 4,002 mi, the second-longest storm on record for distance traveled. On December 19 satellite data detected a tropical disturbance moving slowly east-northeastward near 9°N, 177°E, where weak steering currents existed. Steering was primarily influenced by winter-season westerlies, which extended far into the subtropics. During the next few hours, satellite data indicated slow intensification, while a well-defined, comma-shaped cloud was becoming evident. On the 20th the system became quasi-stationary near 10°N, 179°E, as the westerlies gradually receded northward. During this period the system grew to tropical-storm strength as GOES imagery indicated increased outflow to the north.

After 1200 on the 21st the storm began to accelerate westward. On the 22d Mary turned toward the west-northwest. By 0000 on the 23d Mary reached typhoon intensity as satellite data indicated formation of an eye. The first aircraft reconnaissance entered the storm at 0115 on the 24th and reported 90-kn maximum surface winds and 75-kn winds at 700 mb. Satellite data also estimated the storm's intensity to be 75 kn. About 5 hr later, Mary began to decelerate, turned northward, and appeared as though recurvature was beginning. The subtropical ridge established itself; Mary responded by looping clockwise, and she was subsequently influenced by the northerly flow around the eastern edge of a strong, eastward-migrating anticyclone. The storm now moved south-southwestward at 5 kn. Satellite data (fig. 39) indicated Mary had continued to intensify, and on the 25th aircraft reconnaissance indicated a central pressure of 947 mb with maximum sustained surface winds of 100 kn. Just 3 hr later, Utirik Atoll, 55 mi southeast of Mary, recorded winds of 40 kn.

Mary soon began to accelerate to 12 kn and moved to the west-southwest along the southeastern periphery of the strengthening subtropical high cell. By the 26th satellite data indicated that Mary had weakened, and she was downgraded to a tropical storm.

By the 28th Mary was moving west-northwestward in response to another trough-induced weakness in the subtropical ridge. She again slowed and intensified (fig. 40). As the trough moved rapidly eastward, Mary turned west-southwestward and began to weaken for the second time. Mary moved westward for the next several days. Weakening slowly, she was downgraded to a tropical depression at 0000 on January 1. The system maintained 30-kn winds until moving over the central Philippines near Leyte Gulf. Satellite data indicated rapid dissipation over land. Mary turned sharply southward over the Philippines and encountered the strong northeast monsoon, which aided dissipation.

Although Mary was not the longest lived storm on record, the 4,002-mi distance traveled was the second longest. What is also noteworthy is that there were no injuries or major damage during her long journey across the western Pacific. Mary was indeed a fitting end to a most unusual tropical-cyclone year.

ACKNOWLEDGMENTS

The Editor expresses his appreciation to the Joint Fleet Weather Central and Typhoon Warning Center, Guam, for their outstanding cooperation in supplying the information from their "Annual Typhoon Report" on which this article is based, including track charts and photographs.

## CENTRAL NORTH PACIFIC TROPICAL CYCLONES

No tropical cyclones developed over the central North Pacific during 1977.

# THE BLIZZARD OF '78

Mariners Weather Log

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Forecast Office
National Weather Service, NOAA
Boston, Mass.

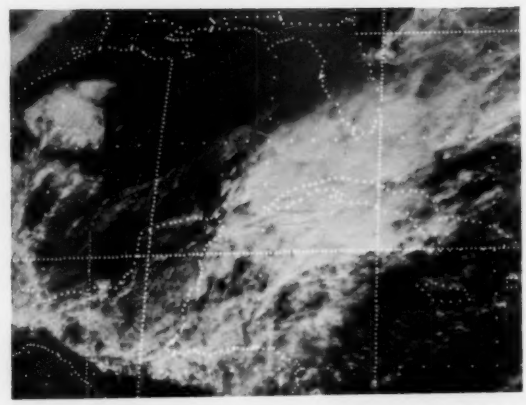
After recovering from the reeling effects of a record-breaking January snow storm (fig. 41), New England was hit with a storm that will go down in the record books as the "Blizzard of '78." This storm, which began here on February 6, produced officially measured wind gusts of over 80 kn at Chatham, Mass. The steady winds at Boston, Mass., were measured at over 53 kn with gusts over 70 kn.

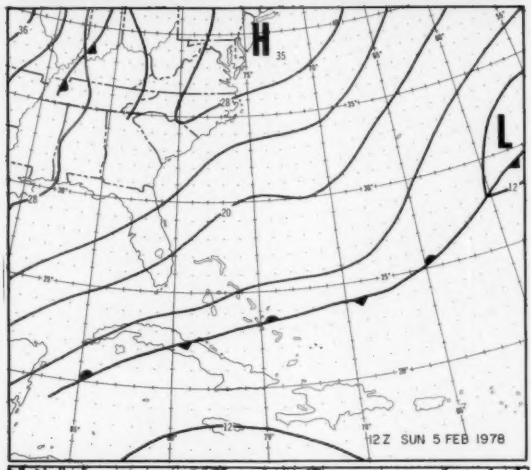
Vessels operating in New England waters during the course of the blizzard were put to the severest test with some of them running aground or sinking. Before we get into the details of these incidents, let's look at how such a mighty blizzard develops.

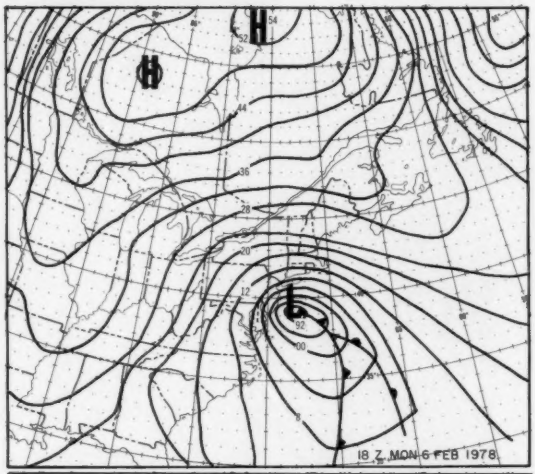
In order to produce a low-pressure system, certain ingredients must combine to cause abnormally fast-rising air, which is then subjected to lower pressure, cooling, and condensation. First, the air in the upper atmosphere in the vicinity of the cyclone formation must be continually replaced by colder air, and this must be occurring at a rapid rate. Second, the air on the surface should contrast the events in the upper atmosphere by being relatively warm; i.e., it should be flowing from a warm source.

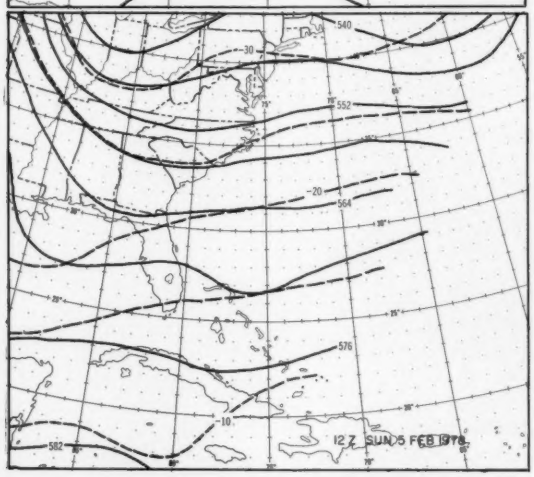
In theory this will result in a rising column of air around which a cyclonic circulation will develop. Theory became practice in early February. On Sat-

Figure 41.--A view of the northwest side of the Hartford, Conn., Civic Center, where the massive roof over the coliseum portion collapsed on January 18 from the weight of water and snow. Wide World Photo.





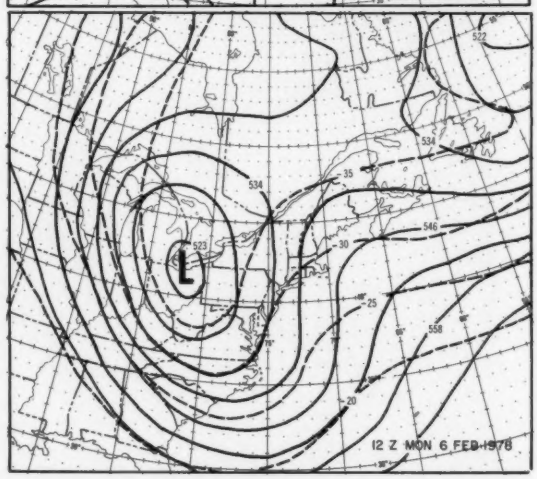
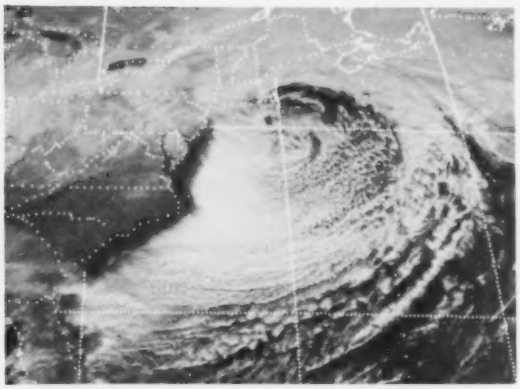
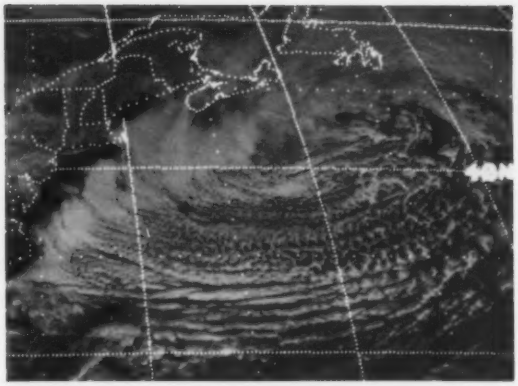



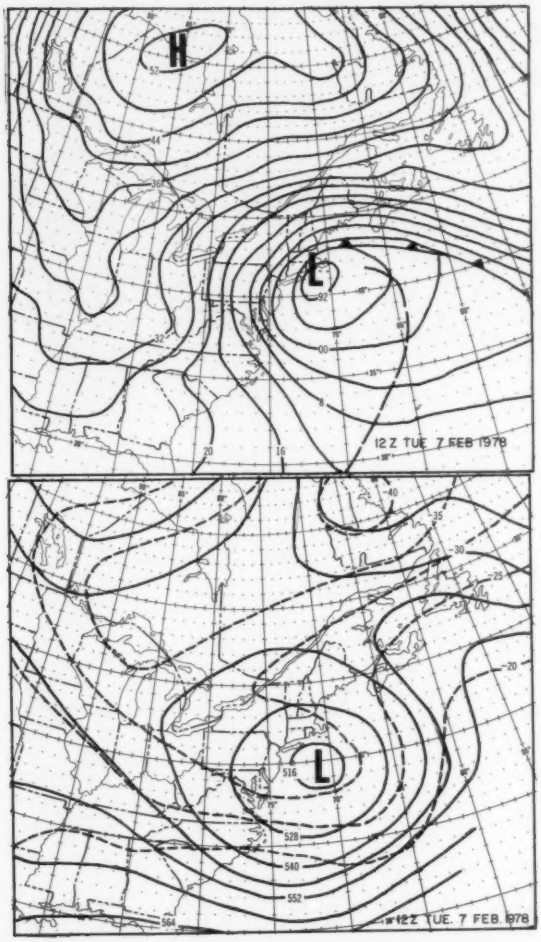

Figure 42

Figure 43

Figures 42 to 45. -- These four figures show the daily development of the historic coastal storm at 1200 on February 5 through 8. The top of the illustrations are the 1700 SMS satellite images; the center the 1200 surface charts; and the bottom the 500-mb upper air charts (heights in tens of meters and temperatures in °C.







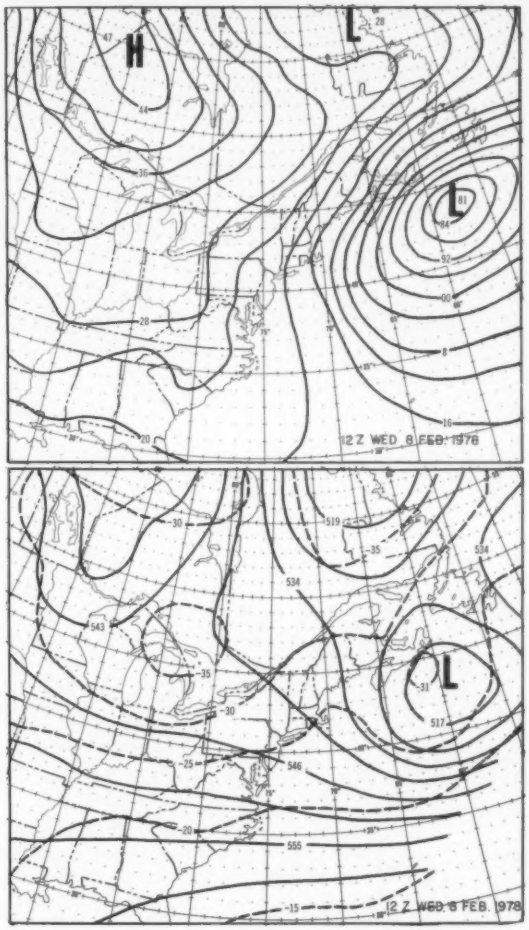




Figure 44

Figure 45

Figure 46.--The tanker GLOBAL HOPE aground in Salem, Mass., after dragging its anchor during the infamous "Blizzard of '78." Photo courtesy of Ralph Turcotte.

Figure 47.--Tugs work to free the GLOBAL HOPE, which was hard aground. Photo courtesy of Ralph Turcotte.

urday, February 4, the temperatures at an altitude of 18,000 ft (500 mb) over Canada were in the -40°C range. This cold air was headed toward the warm Gulf Stream waters off the North Carolina coast, where ocean surface temperatures were in the +20°C range. By Sunday night (the 5th) a definite LOW was forming over the waters off the mid-Atlantic coast. At this point gale warnings were issued by the Weather Service Forecast Office in Boston, and a winter storm watch was on (figs. 42-45). By Monday morning (the 6th) a strong cyclonic circulation appeared on satellite pictures, and ships between New York and Bermuda were reporting gusts of 50 kn with very heavy seas. In Boston, with the winds increasing, the snow was holding off along a line stretching from Nantucket westward. The radar picture looked like a heavy curtain that was being drawn slowly, but surely, northward.

That night, under the action of 50-kn winds and very rough seas, the oil tanker GLOBAL HOPE dragged its anchor in Salem Harbor while waiting to unload its cargo of No. 6 bunker fuel (fig. 46). The tanker went hard aground in the harbor and now posed the threat of a major oil spill as rough seas battered it against the

bottom. Some of the compartments gave way, and oil was released. Several attempts were made by the Coast Guard to reach the ship and its 32-man crew, but visibilities down to zero along with 50-kn winds and 20-ft seas turned them back. Waves as high as 30 ft were reported.

Meanwhile, the 50-ft vessel CAN DO was responding to the stricken tanker's call for help. The boat, with its crew of five, struggled against the heavy seas and strong winds. Waves crashed over the boat with such force that the pilot house was destroyed. For the next 6 hr the crew tried to ride out the storm, but the blizzard was too great for this little boat. On Tuesday morning (the 7th) the CAN DO and its crew were lost. Ironically, later that morning, all 32 crewmembers of the oil tanker were brought safely ashore by the Coast Guard (fig. 47).

The surging water claimed its victims not only from vessels at sea, but also along that ever-changing boundary between sea and land, the coastal zone. All night on the 6th and on the 7th warm air was pumped into the system, fueling the great storm. During this period spring tides were also occurring along the New England shore. The continued presence of the fierce easterly winds during the several cycles of this very high astronomical tide brought water to the highest reaches recorded at Boston in this century. The astronomical tide at Boston was 11.4 ft at 1100 EST on the 7th. Added to this was a storm surge of over 3 ft for a 14.7-ft tide above mean low water. About 2 hr earlier the storm surge had reached about 4 ft, but the total height above mean low water was less due to a lower astronomical tide height. Portland, Maine, also recorded a new record high tide of 14.3 ft, breaking the previous record set only a month earlier on January 9, 1978, during another storm.

Destruction along parts of the New England coast was enormous. Damage was estimated at $400 million. Houses along the coast were piled on top of one another as the raging sea carved their foundations out from under them. Where the foundations held, the crashing waves often reduced the structures above to match wood. Thousands were evacuated from their homes in "protected areas" as 10- to 20-ft waves topped seawalls and other barriers, spilling into the streets. Debris, abandoned cars, and boats as long as 45 ft were strewn about the area.

During this period satellite photographs showed the storm south of Cape Cod along latitude 40°N with a hurricane-like eye and circulation (fig. 48). Tuesday

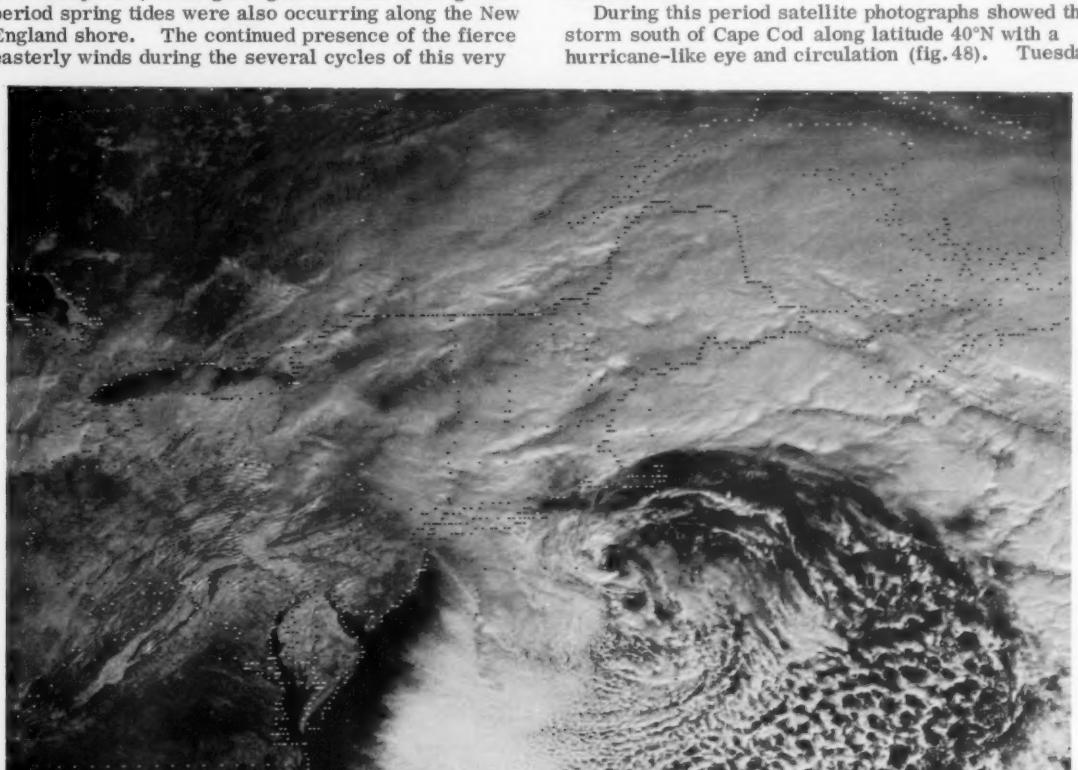


Figure 48.--Spectacular SMS view of the "Blizzard of '78" at 1601 February 7. The center is just south of Cape Cod.

Figure 49.--Ocean water and chunks of ice fill this street in Revere, Mass., early on the 9th. Wide World Photo.

Figure 50.--A bird's eye view of the damage wrought to the New England coastline.

Figure 51.--A close look at the damage. Waves topped the seawall which appears to be about 5 ft high. American Red Cross photo by Philip Gibson.

evening the worst of the storm was over as the center moved eastward along that latitude. In the end 2,100 houses were destroyed and 10,000 were damaged (figs. 49 to 51). Snowfall as high as 4 ft was reported in Rhode Island, although most reports were of 2 to 3 ft. There were several cases of roofs collapsing from the weight of the snow. Thousands of motorists were stalled on the highways of the Northeast. Airports were closed for as long as 48 hr, and power outages affected thousands of people. Finally, much of the states of Massachusetts, Rhode Island, and Connecticut were officially closed for as long as 1 week in the wake of the Blizzard of '78.

# Hints to the Observer

## METHOD FOR COMPUTING TRUE WIND

The following method for computing the true wind from the apparent wind using only a pair of dividers and a Maneuvering Board (fig. 52) was submitted by 2d Officer Michael J. Carlin of the Sea-Land CHARLESTON.

To prepare a corresponding diagram lay out a scale of ship's speed and draw 32-point radiating lines from normal speed. Label various bow, beam, and quarter indicators. Note they are reversed from ship directions. Dashed lines of the example should

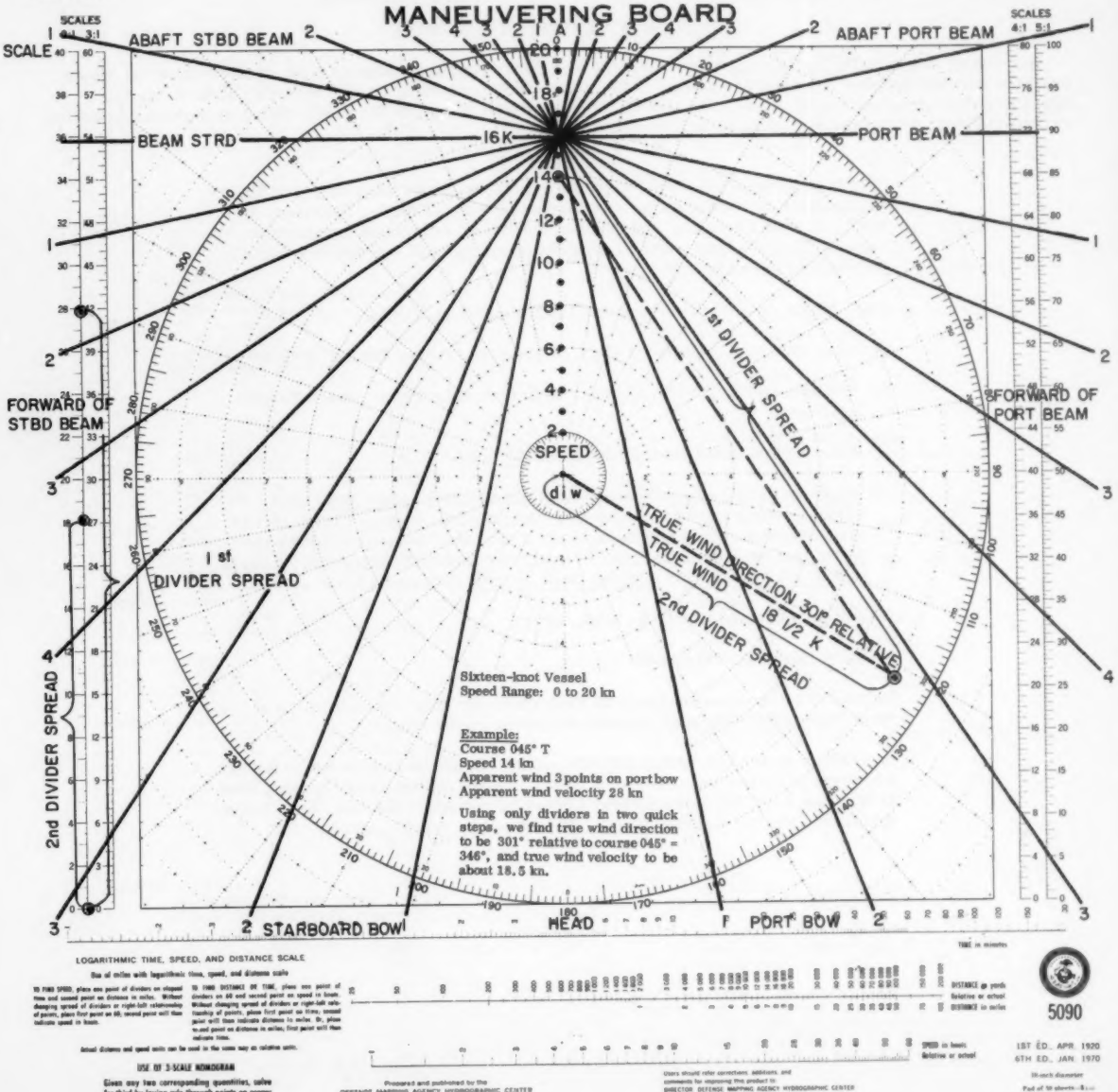



Figure 52.--Use of the Maneuvering Board to convert apparent wind to true wind.

not be copied, unless it is wanted for use as an example. Label radiating lines as points or the radiating lines could be drawn in degrees and so labeled.

In this example the vessel is on a course of 045° true, speed 14 kn, apparent wind 3 points on port bow, with a speed of 28 kn. Using the appropriate speed scale, lay off the apparent windspeed from ship's actual speed paralled to the appropriate line radiating from the ship's normal speed. From this point measure the distance to the center of the Maneuvering Board (dead in water) with the dividers and note the relative direction. Using the same speed scale, determine the true windspeed. Using the relative true wind direction, apply the ship's course to determine the wind direction relative to true north.

For high winds off the stern a second diagram can be constructed using a smaller scale or the radiating lines toward the quarter can be extended visually off the Maneuvering Board. Also, the diagram can be extended by adding a blank sheet and extending the radiating lines.

## LOCUST REPORTS FROM SHIPS

Swarms of locusts are threatening eastern Africa and have already invaded the Horn of Africa. It is requested that ships operating in the seas around Africa, Arabia, Pakistan, and India submit locust reports in accordance with Annex 5-A of the World Meteorological Organization's Guide to Marine Meteorological Services, which is reproduced below.

Members concerned should instruct reporting ships, regardless of their nationality, operating in the seas around Africa, Arabia, Pakistan, and India, to send by radio, and in plain language, reports on any locusts seen to "Telex 24364 – Anti-Locust London" through Portishead Radio Station (United Kingdom).

Each locust report should contain the following elements:

(a) Date and time (specifying GMT or zone time) when locusts first seen;

(b) Latitude and longitude, if possible to nearest minute, where locusts first seen;

(c) Time and position at which locusts last seen;

(d) Whether isolated locusts (seen in flight singly), locust groups(s) (flying locusts seen intermittently in numbers), swarm (flying locusts seen continuously in numbers, over a period of at least a minute), dense swarm (obscuring part of horizon or other background, locusts appearing on board or floating dead locusts (isolated groups or swarms);

(e) Colour of locusts (yellow, pink, grey);

(f) Wind direction and speed.

Details of such reports should be entered in the ship's meteorological log, even when it has not been possible to send a radio report.

In addition to sending locust reports, ships should be instructed to collect, wherever practicable, specimens of the locusts observed and to post them as soon as possible to the Desert Locust Information Service, Anti-Locust Research Centre, College House, Wright Lane, London, W. 8.

# Tips to the Radio Officer

Thomas H. Reppert
National Weather Service, NOAA
Silver Spring, Md.

## CORRECTIONS TO WORLDWIDE MARINE WEATHER BROADCASTS, JULY 1977 EDITION

All times are GMT and frequencies kHz, unless otherwise noted.

Page 8 1-0220 New Station
TAMPA, FLA, U.S.A. (WPD)
Area: SW North Atlantic, Florida Straits, Gulf of Mexico

| | | |
|---|---|---|
| 1420, 2020 | 420<br>4274<br>6446<br>8615.5<br>13051.5<br>17170.4 | W, F |

Page 11 1-0520
KIEL, FED. REPUBLIC OF GERMANY (DAO)
Delete freq 474. Insert 470

1-0550
Delete station name and call sign. Insert, HORTA, AZORES (CTH)

1-0560
MONSANTO, PORTUGAL (CTV, CTU)
Replace times and freqs.

| | | |
|---|---|---|
| 0800 | 418<br>4235<br>8526<br>13002 | W, F,<br>SR, LR |
| 2000 | do. | W, F |
| 0555, 1155,<br>1755, 2355 | do. | A |

Page 15 1-0702
JUNCAO, BRAZIL (PPJ)
Delete Freqs. 8520, 12840, 17170.
Insert 8460, 12689.5, 16918

Page 18 1-0860
KODIAK, ALASKA (NOJ)
Delete times. Insert 0530, 1930.

Page 18 1-0880
VANCOUVER, B.C., CANADA (VAI)
Delete times. Insert 0130, 0530, 1730

Page 22 1-1230 New Station
HO CHI MINH-VILLE, VIETNAM (XVS)
Area: China Sea, Gulf of Thailand
7°N-22°N, 99°E-120°E

| | | |
|---|---|---|
| 0048, 0448,<br>1148 | 460<br>8590 | W, F |
| 0420, 1020,<br>1620, 2320 | 5263<br>8194<br>14975 | W, F |

Page 24 1-1360
MELBOURNE, AUSTRALIA (VIM)
Delete times and freqs. Insert,
0948, 2318 430
4228
6333.5

1-1370
BRISBANE, AUSTRALIA (VIB)
Add freq. 4230.5

Page 27 1-1570
DJIBOUTI, AFARS AND ISSA (J2A)
Delete station

Page 29 1-1780
PERTH, AUSTRALIA (VIP)
Delete freqs. Insert 8597, 12994

Page 36 2-0270
CAPE MAY, N.J. (NMK)
Delete times and freqs. Insert,
1103, 2303 2670

2-0280
BALTIMORE, MD (NMX)
Delete station

Page 42 2-0880
MARIEHAMN, FINLAND (OFH)
Delete times. Insert 0833, 2033

PAGE 46 2-1160
SAN FRANCISCO, CA (NMC)
1530, 1900, 157.1 MHz
2330

2-1181
ADAK, ALASKA (NMJ-21)
Delete station

2-1190
ATTU, ALASKA (NMJ-22)
Delete station

2-1200
CAPE SARICHEF, ALASKA (NRW)
Delete station

Page 47 2-1230
KODIAK, ALASKA (NOJ)

| | |
|---|---|
| 0203, 0445, 0903,<br>1415, 1645, 2103 | 2670, 6506.4 |
| 0030, 0230, 0530,<br>1330, 1800 | 157.1 MHz |

2-1250
OCEAN CAPE, ALASKA (NMJ-19)

| | |
|---|---|
| 0145, 0845<br>1345, 2045 | 2670 |
| 1345, 2045 | 157.1 MHz |

Page 48 2-1310
SANDSPIT, B.C., CANADA (VAH)
Delete freq. 161.9 MHz, Insert 161.65 MHz

2-1330
ALERT BAY, B.C., CANADA (VAF)
Delete freq. 161.9 MHz

2-1350
TOFINO, B.C., CANADA (VAE)
Delete freq. 161.9 MHz

2-1360
COMOX, B.C., CANADA (VAC)
Delete freq. 161.9 MHz

2-1370
VANCOUVER, B.C., CANADA (VAI)
Delete times and freqs. Insert,
2115, 0010, 0310 1630

1610, 1910, 2210, 161.65 MHz
2310

2-1380
VICTORIA, B.C., CANADA (VAK)
Delete freq. 161.9 MHz

Page 49 2-1470
HUMBOLDT BAY, CA (NMC-11)
0303, 1503 2670

1545, 2315 151.1 MHz

Page 56 3-0020
HALIFAX, N.S., CANADA (CFH)
Add freq. 6330

Page 57 3-0090
NORTHWOOD, UNITED KINGDOM
Change call sign to: (GYA, GYJ, GZZ)
Delete freqs. Insert 4247.85, 6492.35, 8494.85 kHz

Page 58 3-0150
PARIS, FRANCE
131.8, 4047.5, 8185, 12305 kHz

| | |
|---|---|
| 0342, 0946, 1536, 2145 | Surface analysis |
| 0514, 1714 | 24-hr surface prognosis |
| 0835, 2030 | Surface analysis |
| 0840 | 12-hr wave prognosis |
| 0845 | 36/48-hr wave prognosis |
| 0958 | 30-hr surface prognosis |
| 1003 | 48-hr surface prognosis |
| 1840 | Sea temperature |

Page 59 3-0175 New Station
MONSANTO, PORTUGAL (CTU, CTV, CTW)
Area: 40°N-110°W, 52°N-28°E
14°N-70°W, 18°N-09°W
4235, 8526, 13002 kHz

| | |
|---|---|
| 0635, 1710 | Surface analysis |
| 1110, 2120 | 24-hr surface prognosis |
| 1835 | Wave analysis |
| 2135 | 24-hr wave prognosis |

3-0180
DAKAR, SENEGAL (6VU, 6VY)

| | |
|---|---|
| 0400, 1000, 1600, 2200 | Surface analysis |
| 1015, 2215 | 24-hr surface prognosis |
| 0340, 0940, 1140, 1540, 2340 | Test chart |

Page 62 3-0280
RIO DE JANEIRO, BRAZIL (PWZ)
Delete time 1700. Insert 1800.

Page 64 3-0385 New Station
BEIJING (PEKING), PEOPLES REPUBLIC OF CHINA (BAF)
5525, 8120, 10115, 12110, 14365 kHz

| | |
|---|---|
| 0020 | Surface analysis |
| 0409 | 24-hr surface prognosis |
| 0924 | Tropical analysis |
| 1103, 2320 | *Typhoon track forecast |

*When necessary

3-0390
BANGKOK, THAILAND (HSW)
Delete freqs. Insert 6765, 7395, 17520 kHz

Page 71 4-0040
MOBILE, ALABAMA (WLO)
Delete times and freqs. Insert,
1130, 1730, 2330 6501.5 8707, 13073.5, 17224.0

Page 77 ADD: Lewes, DE WXJ-94 162.55

Much of the information contained in Worldwide Marine Weather Broadcasts has been provided by radio officers. Radio stations around the world frequently change broadcast schedules and frequencies with little mention beforehand, and formal announcements of planned changes are rarely received. Comments from radio officers, based on daily experiences, have been an invaluable source of information for updating and maintaining this publication.

When broadcast changes and corrections are received, the information is reported as submitted. Usually, corroboration is obtained from reports from other radio officers and through the World Meteorological Organization or other official sources.

ACKNOWLEDGMENTS

Thanks are extended to J. Miller Porter, Jr., SS TILLIE LYKES; Lyman G. Hailey, SS EXPORT DIPLOMAT; and Alan Van Sickle, SS AMERICAN ASTRONAUT for recent information relative to the marine program.

WE OF NOAA ARE MAKING USE OF THIS SMALL AMOUNT OF SPACE TO EXTEND OUR THANKS TO ALL THE SHIPS' OFFICERS WHO ROUTINELY TAKE SHIPBOARD WEATHER OBSERVATIONS. TO US THESE EXCELLENT OBSERVATIONS ARE PRICELESS. WE CERTAINLY DO APPRECIATE RECEIVING THEM ON A REGULAR BASIS.

# Hurricane Alley

Dick DeAngelis
Environmental Data Service, NOAA
Washington, D.C.

Two tropical cyclones (tropical storms and hurricanes) developed in both the South Indian Ocean and the Australia-South Pacific region during March and April (fig. 53). Two reached hurricane strength. This is well below the average for these waters, where a total of nine tropical cyclones usually develop. A number of storms never developed beyond the tropical-depression stage.

## SOUTH INDIAN OCEAN
## MARCH AND APRIL 1978

This basin said hello to Mary Lou on March 16. She formed about 400 mi southwest of the Diego Garcia Islands. For the first few days she meandered southward, slowly intensifying. By the 19th winds reached 50 kn near her center, while gales extended more than 100 mi in all directions. Mary Lou never developed further as she moved erratically southeastward. On the 21st she passed about 200 mi northeast of Rodriquez (fig. 54). The following day she began to weaken. Meanwhile, Winnie was coming to life about 600 mi to the northeast. Winnie was more potent than Mary Lou and by the 21st was at hurricane strength. Maximum winds reached a peak of about 90 kn as the storm developed rapidly. She remained at hurricane strength until the 24th. At this time Winnie was turning a counterclockwise loop. After several days of traveling southwestward, Winnie recurved and turned extratropical.

Figure 54.--Tropical storm Mary Lou is poorly organized and dissipated the following day.

## SOUTH PACIFIC - AUSTRALIA
## MARCH AND APRIL 1978

Toward the end of March Alby sprung to life in the waters off the northwest coast of Australia. Before

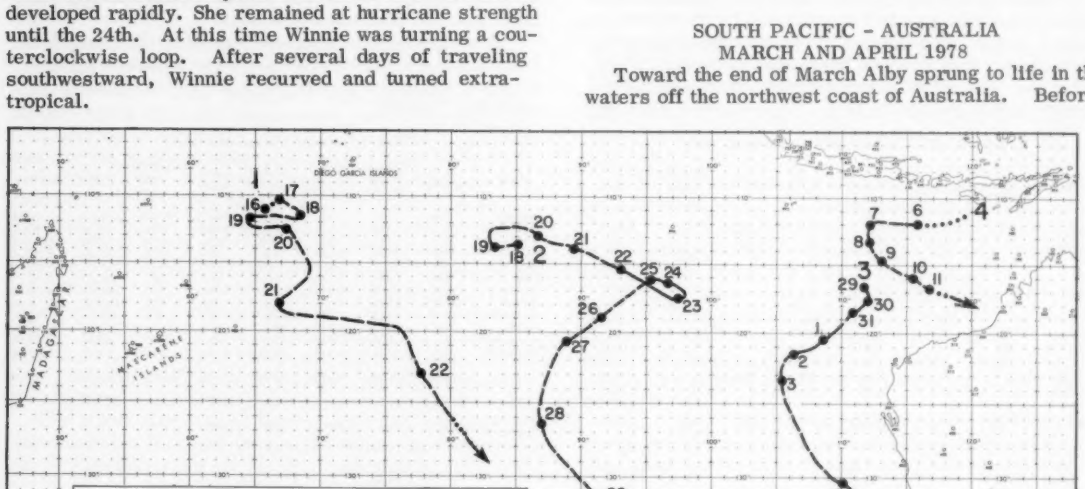

DIEGO GARCIA ISLANDS
MADAGASCAR
MASCARENE ISLANDS
TROPICAL CYCLONES ORIGINATING IN THE SOUTHERN HEMISPHERE DURING MARCH AND APRIL 1978
NO. NAME INTENSITY DATES
1. MARY LOU T MAR. 16-22
2. WINNIE H MAR. 18-29
3. ALBY H MAR. 29-APR.5
4. BRENDA T APR. 5-11
(H) Hurricane (winds 64 kt. or higher)
(T) Tropical Storm (winds 34 through 63 kt)
Tropical Depression stage
Tropical Storm stage
Hurricane stage
Position at 0000 GMT

Figure 53.--Tracks of Southern Hemisphere tropical cyclones, March and April 1978.

the month was out he was a hurricane (fig. 55). Maximum winds reached 70 kn for a brief time on April 1. By the 2d Alby had dropped back to tropical-storm strength and was recurving toward the southeast. However, he was still a potent storm. The BEECHWOOD, about 180 mi northwest of the center at 1200, was battling southwesterly 45-kn winds in 30-ft seas. For the next 2 days the ship was engulfed in rough seas and gales even though Alby moved far to the southeast. On the 6th the storm brought strong winds to Perth, causing widespread blackouts, bushfires, and severe property and crop damage. At least two people died after their yacht was swept out to sea by strong winds and high seas near Bunbury, south of Perth. A tug sent out to rescue them was also feared lost.

While Alby was turning extratropical on the 5th, Brenda was coming to life just south of Sumba. After moving westward for a few days, she began to recurve toward the southeast. Brenda reached peak intensity on the 9th as winds approached hurricane strength. However, she weakened rapidly as she approached the northwest coast of Australia on the 11th.

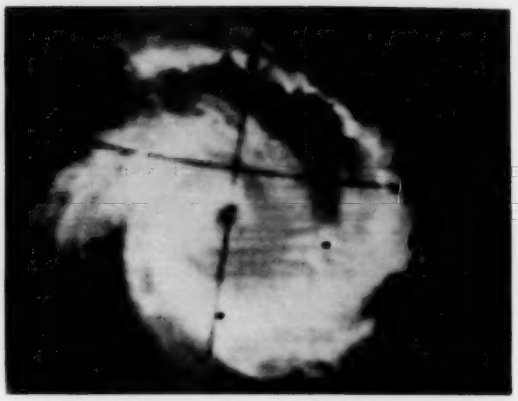


Figure 55.--Hurricane Alby presents a typical Southern Hemisphere signature on March 31. Note the clockwise circulation.

## 1977 GLOBAL TROPICAL CYCLONE ACTIVITY

Overall 1977 tropical-cyclone activity was well below average. The biggest deficits are found in the eastern and western North Pacific basins. However, every basin suffered to some extent. Table 5 is a box score for the past season. This can be compared with the overall standings since 1965 in table 6.

In these tables the figures represent the number of tropical cyclones (tropical storms and hurricanes; i.e., winds $\geq$ 34 kn). The figures in parentheses represent those storms that reached hurricane intensity (winds $\geq$ 64 kn). The dividing line between the eastern and western North Pacific is 180°. The dividing line between the South Indian Ocean and the Australia-South Pacific region is 100°E. Storms originating in one basin and moving into another are only counted for the basin in which they originated. Using the calendar year, unfortunately, spilts the Southern Hemisphere season in two, but it is valuable in comparing global activity by month. For the first time, we have been able to include the North Indian Ocean storms that have reached hurricane intensity.

These global data may lead to comparisons between basins and hemispheres. In future columns we will go back and present year-by-year statistics and, if possible, tracks.

Table 5.--Final tropical-cyclone standings, 1977

| Month | North Atlantic | Eastern North Pacific | Western North Pacific | North Indian | South Indian | Australia-South Pacific | Total |
|---|---|---|---|---|---|---|---|
| January | 0 | 0 | 0 | 0 | 3(3) | 4(2) | 7(5) |
| February | 0 | 0 | 0 | 0 | 2(2) | 1 | 3(2) |
| March | 0 | 0 | 1 | 0 | 0 | 3(1) | 4(1) |
| April | 0 | 0 | 0 | 0 | 0 | 2(1) | 2(1) |
| May | 0 | 1 | 0 | 1 | 1 | 0 | 3(0) |
| June | 0 | 1 | 1 | 1(1) | 0 | 0 | 3(1) |
| July | 0 | 1(1) | 4(3) | 0 | 0 | 0 | 5(4) |
| August | 1(1) | 1(1) | 1 | 0 | 0 | 0 | 3(2) |
| September | 3(3) | 3(1) | 5(2) | 0 | 0 | 0 | 11(6) |
| October | 2(1) | 1(1) | 4(3) | 1 | 0 | 0 | 8(5) |
| November | 0 | 0 | 2(2) | 2(2) | 1(1) | 2 | 7(5) |
| December | 0 | 0 | 1(1) | 0 | 1 | 2 | 4(1) |
| Total | 6(5) | 8(4) | 19(11) | 5(3) | 8(6) | 14(4) | 60(33) |

Table 6.--Tropical cyclones, 1965 to 1977

| Month | North Atlantic | Eastern North Pacific | Western North Pacific | North Indian | South Indian | Australia-South Pacific | Total | Average |
|---|---|---|---|---|---|---|---|---|
| January | 0(0) | 0(0) | 9(5) | 2(1) | 29(17) | 52(20) | 92(43) | 7.1(3.3) |
| February | 0(0) | 0(0) | 4(1) | 0(0) | 30(16) | 41(16) | 75(33) | 5.8(2.5) |
| March | 0(0) | 0(0) | 5(1) | 0(0) | 15(5) | 39(18) | 60(24) | 4.6(1.8) |
| April | 0(0) | 0(0) | 11(8) | 4(2) | 6(1) | 18(6) | 39(18) | 3.0(1.4) |
| May | 1(1) | 5(3) | 14(10) | 14(5) | 3(0) | 4(3) | 41(22) | 3.2(1.7) |
| June | 7(4) | 24(9) | 20(13) | 5(1) | 0(0) | 0(0) | 56(27) | 4.3(2.1) |
| July | 11(6) | 41(16) | 60(35) | 2(0) | 1(0) | 2(0) | 117(57) | 9.0(4.4) |
| August | 30(22) | 53(31) | 67(38) | 2(1) | 0(0) | 0(0) | 152(92) | 11.7(7.1) |
| September | 37(23) | 41(20) | 63(43) | 11(4) | 1(0) | 0(0) | 153(90) | 11.8(6.9) |
| October | 15(9) | 20(10) | 50(40) | 16(7) | 5(3) | 4(1) | 110(70) | 8.5(5.4) |
| November | 3(2) | 4(0) | 34(19) | 19(8) | 5(2) | 18(7) | 83(38) | 6.4(2.9) |
| December | 0(0) | 0(0) | 11(4) | 11(4) | 21(6) | 33(15) | 76(29) | 5.8(2.2) |
| Total | 104(67) | 188(89) | 349(218) | 86(33) | 116(50) | 211(86) | 1,054(543) | |
| Average | 8.0(5.2) | 14.5(6.8) | 26.8(16.8) | 6.6(2.5) | 8.9(3.8) | 16.2(6.6) | 81.1(41.8) | |
| Percent hurricane | 64% | 47% | 62% | 38% | 43% | 41% | | |

# On the Editor's Desk

## LIGHTNING A THREAT TO SMALL-BOAT OPERATORS

NOAA does not want to spoil your day on the water with a foul-weather forecast, but here is a prediction that boaters had best heed.

Small boats on the water during a thunderstorm attract lightning like chum attract fish. If you or any of your passengers present a higher profile than does most of your craft, there is a good chance of getting struck by lightning.

Experts with the National Weather Service say that outriggers, a flying bridge, or even the tip of a fishing rod can become the beginning of a deadly journey for 100 million volts of searing lightning. If you are between it and its natural path to the ground (in this case

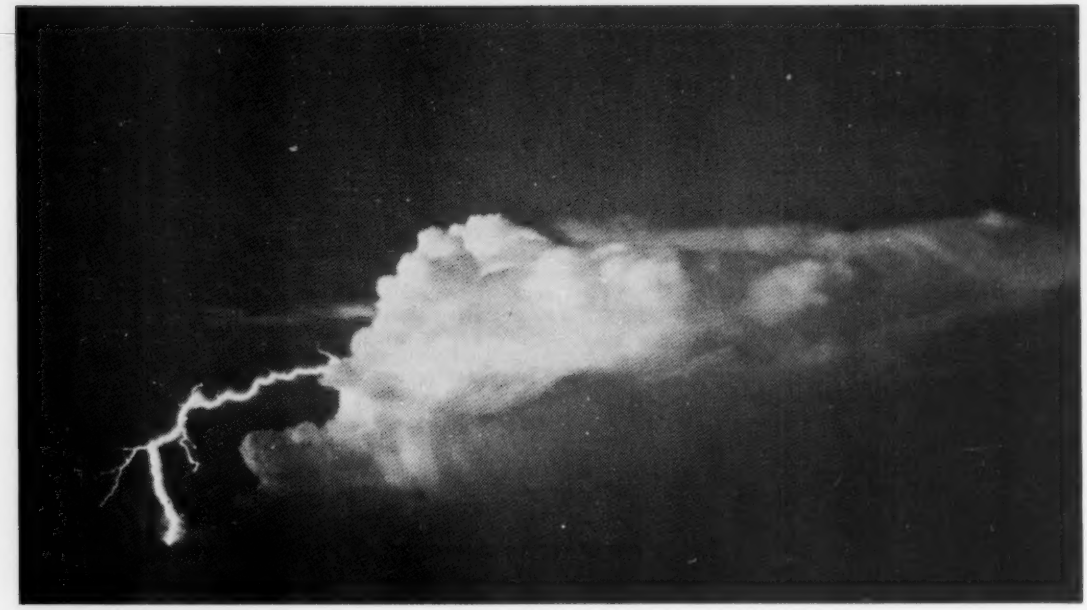


Figure 56.--"Bolt from the blue." This photograph of lightning shows it striking away from the cloud.

the surface of the water), it can kill you. According to NOAA lightning has killed more people during the past 3 decades than tornadoes and hurricanes combined. More than 100 deaths each year were directly attributable to lightning, and of these about 10 percent were on or near the water.

How can you, the small-craft operator, protect yourself? First, pay attention to National Weather Service forecasts and warnings. If thunderstorms are in the offing, don't put out in your small craft. Commercial radio and television stations and Coast Guard frequencies in all coastal areas carry frequent weather reports for boating interests. NOAA Weather Radio, broadcasting continuous weather information 24 hr a day on VHF-FM, can be picked up in most areas. Also, a bit of eyeball meteorology can tell you that a thunderstorm is brewing.

If you are already out in your boat and you hear a thunderstorm forecast or see the billowing thunderstorm clouds, make for shore immediately. It's best not to take a chance that the storm will miss you.

Along with the lightning hazard, strong, gusty winds and rough seas are often associated with a thunderstorm, creating an additional danger to the small-boat operator.

If you cannot make it to port when a thunderstorm threatens, get below decks if possible; the cabin will offer some protection. Use your two-way radio only in an emergency. Its antenna is a natural lightning attractor. Some boats are equipped with lightning arrestors, but don't take chances. Try to avoid handling wiring and metal fittings.

In a small boat with no overhead protection, keep low as you head for shore. If you can see clearly to navigate, sit on the bottom of the boat with most of your body below the gunwales. Remember, lightning strikes do not always come down just below the thundercloud. They may jump several miles from the cloud and strike where the sky is clear overhead. (fig. 56).

Lightning strikes are not always fatal. If someone on your boat is struck, first aid in the form of artificial respiration for a victim who is not breathing, and cardiopulmonary resuscitation for one whose pulse has stopped, may bring about full recovery.

When a group is affected, the apparently dead should receive first aid immediately. Those unconscious but breathing will probably recover spontaneously. Professional medical attention, of course, should be sought for anyone struck by lightning as quickly as possible.

Small boats and bad weather do not mix. Follow the National Weather Service's advice on boating in thunderstorm weather, keep abreast of weather forecasts and information, and live to sail another day.

## POLLUTION REPORTING

Coast Guard pollution regulations require that when oil or a hazardous substance has been discharged into the navigable waters of the United States, the person in charge of the responsible vessel or facility must notify the Coast Guard immediately. Failure to report an incident can result in a fine of up to $10,000, imprisonment up to 1 yr, or both.

The simplest and preferred way of reporting pollution incidents is by calling the toll-free number of the National Response Center. The center, located at the

Coast Guard Headquarters in Washington, is manned 24 hr a day. It is specially equipped and staffed to facilitate reporting and to ensure the timely response necessary to minimize environmental damage.

To make a report to the National Response Center, dial 800-424-8802.

## ICEBERG TRACKING

Scientists from the Coast Guard Research and Development Center at Groton, Conn., have tagged five large tabular icebergs in Baffin Bay with satellite-tracked "ice buoys."

The devices, called ADRAMS (Air Deployable Random Access Monitoring System) icebuoys, are being tracked by the Nimbus 6 satellite. The satellite relays the external temperature of the buoy and computes the geographic location from which the signals are being beamed. Each buoy is assigned a number so that many can be monitored at the same time.

The buoys were parachuted from a Coast Guard C-130 aircraft sent from the Elizabeth City, N.C., Air Station. All of the icebergs were well north of the Arctic Circle at the time they were tagged, four being on the Baffin Island side of Baffin Bay, and one on the Greenland side.

The bergs, which were up to 1/2 mi in length, are expected to drift south toward the Grand Banks of Newfoundland.

## SCIENTISTS TRACE GULF STREAM MEANDERS

NOAA satellites are helping scientists explore and map the intricate, meandering collection of ocean currents stemming from the Gulf Stream. This complex system can now be mapped in detail from the tip of Florida to Labrador's Grand Banks in 2 days--a task formerly requiring weeks of ship time.

This is one of the results of a study reported at a recent meeting of the American Geophysical Union in Miami, Fla. The constantly shifting meanders along the west wall of the Gulf Stream, in particular, are of importance to mariners and those concerned with the carry-off of pollutants in coastal waters and other phenomena.

Shipboard time-series studies using current meters and other equipment in the Gulf Stream system indicate that meanders have longer periods in some regions than in others. An annual period seems to dominate the system in the eastern Gulf of Mexico. Meander periods in the region between Cape Hatteras, N.C., and the Grand Banks southeast of Labrador are about 1-1/2 mo. Other shipboard surveys have revealed that the fluctuations in the Gulf Stream current boundary may last 4 to 10 days in the Straits of Florida near Miami, and 4 to 7 days at Onslow Bay, N.C.

Little is known about meander periods briefer than 2 weeks in the Gulf Loop Current and the Gulf Stream northeast of Cape Hatteras or about longer (monthly or annual) periods in the Straits of Florida or off Onslow Bay. It is not practical to simultaneously study meanders along the entire 1,500-mi Gulf Stream system between Cuba and Labrador by conventional shipboard techniques. As a result, it has been concluded that satellite observations of the sea-surface temperature pattern associated with the entire current system is presently the only practical method for synoptically tracking the meanders.

Before the launch of NOAA's first geostationary operational environmental satellite in 1974, many satellite investigations were limited to case studies using a few good cloud-free examples. The GOES satellite, however, has an operational 30-min observation schedule which means the images can be put together in a continuous sequence so that, on the average, the entire current can be located every 2 to 3 days. As a result the entire Gulf Stream from the Yucatan Strait between Mexico and Cuba and the Grand Banks near Labrador, Canada, has been located using satellite-image sequence techniques. A subsequent study of the Gulf Stream using GOES data to investigate meanders off Onslow Bay, N.C., found frequencies similar to shipboard observations made in 1961.

## CANADIAN ICE-STRENGTHENED SHIP

Plans were completed in May for the maiden voyage of Canada's first icebreaking bulkcarrier, the ARCTIC. Canarctic Shipping Company, Ltd., a joint industry-government operating company, has signed an agreement to carry some 81,000 tons of zinc-lead concentrate to Continental Europe this summer from mines in Strathcona Sound, 70 mi east of Resolute in the high Arctic, up around 75°N.

After naming ceremonies at its builders, Port Moller Dry Dock, Ltd., St. Catharines, Ontario, the vessel sailed to Toledo to pick up grain, to be topped off at Montreal to make a full load of 1 million bushels destined for Europe. She will then sail directly from Europe to the Canadian Arctic to load her first shipment of zinc-lead concentrate, destined for Antwerp or Rotterdam. The vessel with its 44-man crew will depart Canadian waters on the first voyage early in July. A second voyage is planned in September and a third in October.

Ice restricts conventional ship movement in the Arctic to 6 weeks or less. The ARCTIC will extend the shipping season to 4 mo. The ship is designed to travel through ice up to 2 ft thick. The ship will be moved to the Upper Great Lakes during the winter.

The vessel is double-hulled and equipped with an air-bubble system designed to reduce ice friction on the hull. It also has a ducted controllable pitch propeller as well as a helicopter-landing pad.

It took 2 yr to build the ARCTIC. She is constructed to Arctic Class 2 regulations and will be carrying instruments to test her increasing capabilities. The Canadian government has a 51-percent interest in Canarctic Shipping. The arrangement is that the government will cover any operating deficits incurred by the ship while operating in the Arctic, but industry will be responsible for operating costs in non-Arctic trade.

The 28,000-ton vessel will serve as the prototype for larger ships expected to be needed for future Arctic commercial operations.

## SCIENTIST CLOCKS 17TH CENTURY SOLAR WIND

A puzzling 17th Century gap in solar activity may hold clues to predicting the Earth's climate.

A scientist at NOAA's Space Environment Laboratory has found that in the late 17th Century the solar wind, the stream of energetic particles that the Sun spits out, slowed to a comparative breeze, and may

have been linked to the occurrence on Earth of the "Little Ice Age." Such a pause in solar activity and its attendant affects on the Earth could happen again at any time.

For 70 yr, from about 1645 to 1715, the 11-yr sunspot cycle considered as normal seems to have disappeared. The few sunspots that did appear were small and short-lived. Displays of the aurora on Earth, which are tied to sunspots, faded, and the solar corona, the halo of glowing gas that becomes visible around the Sun during eclipses, was smaller and duller than it is today. This period of solar quiet is called the Maunder Minimum, after the English astronomer who first postulated it.

At the same time, the Earth was suffering through the coldest part of the Little Ice Age, a period of long, severe winters from about 1450 to 1850. There is a growing number of scientists who believe this was no coincidence.

Evidence is accumulating that solar activity affects the Earth's weather and climate. With the solar wind an obvious intermediary between the Sun and Earth, understanding what it was like during the Maunder Minimum could give clues to how changes on the Sun affect Earth. The solar wind normally races outward from the Sun at a rate of 1.5 million mi/h (700 to 800 km/s) in some places. Elsewhere it may idle along at a mere 670,000 mi/h (300 km/sec).

After studying a variety of evidence including data gathered by the National Center for Atmospheric Research, it was concluded that the solar wind during the Maunder Minimum was comparatively thin, slow, and featureless. In this same period, other data indicates that the bombardment of the Earth by cosmic rays was more intense than at any time since. When solar activity is high, cosmic ray intensity decreases. The dearth of sunspots and the disappearance of an apparent corona led to the inference that the magnetic field of the solar corona was weakened, affecting the interplanetary magnetic field (the extension of the solar field that reaches to Earth and beyond) in such a way as to admit more cosmic radiation.

The aurora on Earth not only are tied to sunspots but are directly related to the speed of the solar wind. The slower the wind, the fewer auroral displays at lower latitudes. Historical records suggest that the zones where aurora are visible shrank closer to the poles during the Maunder Minimum, disappearing from the skies in temperate latitudes where their appearance probably would have been noted and recorded.

Everything points to a low-velocity solar wind and a faint corona with a weak magnetic field. The wind would have been essentially featureless, as well as slow--a homogeneous flow blowing outward with equal force in all directions.

These results may be of more than historical interest. The Sun can no longer be thought of as a nonvarying star on time scales even as short as decades. It is likely that even over the coming 50 yr there will be significant changes in average properties of the solar wind. Observing and understanding these changes will make it possible to better understand past phenomena such as the Maunder Minimum, and, more importantly, to anticipate these changes and gain the benefits of better preparation for their consequences.

## TRANSPORTATION ACCIDENTS, 1977

Transportation deaths in the United States rose nearly 4 percent in 1977--the first significant upturn in 5 yr, according to preliminary statistics released by the National Transportation Safety Board.

Spurred by an increase of 1,357 in highway deaths and a record toll in air travel, fatalities in all modes of transportation rose from 50,208 in 1976 to 52,154 in 1977. This total had risen only 1 percent in 1976 after 3 yr of decline.

Highway fatalities, which historically account for more than 90 percent of all U.S. transportation deaths, last year increased from 45,523 to 46,880. It was the second successive year of increased highway fatalities after 2 yr of decline. The highway toll had dropped nearly 20 percent in 1974 and 2 percent in 1975, before turning upward by 2 percent in 1976 and 3 percent in 1977.

The Safety Board Chairman, in releasing the 1977 statistics said he "cannot overemphasize the Safety Board's concern over this worsening trend in transportation safety. The primary problem area clearly is the Nation's highways, and the danger is a gradual regression to the high-speed days of 5 yr ago, when we were slaughtering nearly 55,000 persons annually with our motor vehicles."

Four of the Board's seven other statistical categories also registered fatality increases in 1977. Airline deaths, swollen by the 327 U.S. and 246 foreign-carrier fatalities in the ground collision of two wide-body jetliners in the Canary Islands, rose from 45 in 1976 to 654 last year. Railroad fatalities increased

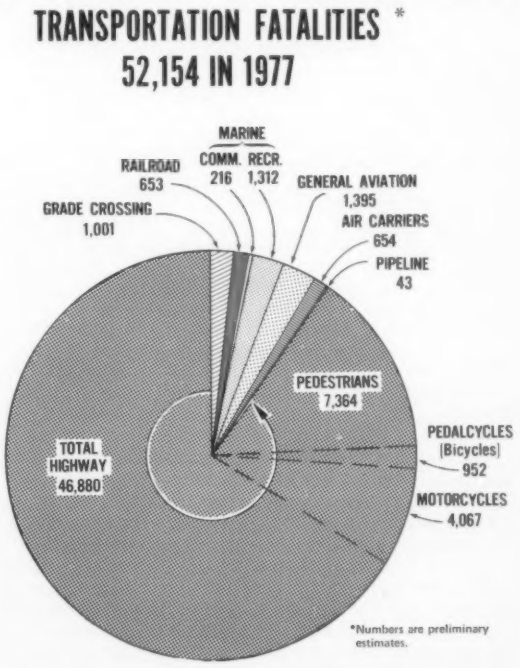



Figure 57.--Pie diagram of transportation fatalities, 1977.

from 590 to 653, an increase of 11 percent. Recreational boating and general aviation each showed a 4-percent increase.

In the highway category, motorcycle fatalities rose from 3,312 to 4,067--an increase of 755 or 23 percent. Other categories registered decreases, with pipelines down from 82 to 43 (48%); commercial marine from 269 to 216 (20%); and rail-highway grade crossings from 1,174 to 1,001 (15%).

The Safety Board's statistics were issued in the form of its annual pie chart of transportation fatalities (fig. 57).

## LORAN-A STATION CLOSING POSTPONED

The Secretary of Transportation has approved a 6-mo postponement of the scheduled closings of U.S. Loran-A radio navigation service in several major coastal areas.

A Coast Guard-funded study of problems associated with Loran-A termination, conducted by Oregon State University, pointed out that planned termination dates coincided with peak operating seasons for most commercial fishermen and many other users of Loran-A. The study recommended that the closings be rescheduled to a period of relatively low maritime activity. The Coast Guard found no evidence, however, that extension of Loran-A in the Aleutian and Hawaiian Islands would be beneficial.

The new closing dates for the stations are: Hawaii and the Aleutian Islands, July 1, 1979, as originally planned; Gulf of Alaska and West Coast stations, December 31, 1979; and Atlantic, Gulf of Mexico, and Caribbean (West Indies) stations, December 31, 1980.

Loran (Long Range Navigation) is an electronic system using shore-based radio transmitters and shipboard receivers to allow ships to locate their positions at sea. Loran-A is being replaced by the newer, more accurate Loran-C system, which is being expanded throughout the coastal waters of the continental United States and southern Alaska. Loran-C will overlap Loran-A until termination of the latter is completed. Once Loran-A is discontinued, only Loran-C will be available. Loran-C's accuracy and dependability have already been proven on the West Coast and in the Northeast, and will give mariners a definite advantage over Loran-A according to Coast Guard officials.

## SCIENTISTS TRACE CARIBBEAN CURRENTS

The surface waters of the Caribbean may retain pollutants longer than existing current charts suggest, according to a NOAA scientist.

Reporting at a meeting of the American Geophysical Union in Miami Beach, NOAA oceanographer Robert Molinari described results from a recent study which used satellite-tracked buoys to trace the circulation of the region.

It was discovered that Caribbean surface currents were much more complicated than had been generally believed, so that water--and any pollutants it may receive--would tend to remain in the Caribbean for months before returning to the Atlantic through the Florida Straits. This longer residence time has implications for environmental impact studies, since any pollutants discharged in the region would remain longer than previously assumed.

The conventional view of currents in the area is based on charts compiled from averaging numerous ship observations spanning the last century. The charts show a simple pattern of water movement in the Caribbean--a flow from east to west, at about a knot or a knot and a half (slightly over a mile an hour) with little north-south variation. The new buoy results show quite a different picture.

For the study, the oceanographer and colleagues at Nova University and the University of Puerto Rico deployed 19 minibuoys at the eastern end of the Caribbean Sea. The buoys carried wind sensors and drogues--a type of underwater parachute that ties the buoy to the water and minimizes the effect of wind. In October 1975 scientists on the NOAA ship RESEARCHER deployed eight of the buoys in the passages between islands of the Lesser Antilles. Three months later 11 more were set afloat, within several passages, and west of the undersea Aves Ridge. Their movements were tracked by satellite, averaged together, and plotted on charts. The results did show a general east-to-west flow, but hardly in a direct line.

The buoys made large excursions to the north and south, carried by meanders (winding currents) and eddies (circular, whirlpool-like motions). In the Grenada Basin, between the Lesser Antilles and the Aves Ridge, eddies as large as 60 mi (100 km) across caught the buoys. Meanders carried them 150 mi (250 km) to the north and south. The course of these meanders described a wave pattern across the sea, watery oscillations with a wavelength of 240 mi (400 km), the same distance between the major ridges in the basin. There are plans for further study to see if the two observations are related.

In the corner of one basin of the sea, it was found in this instance that the waters rotated in the opposite direction from that shown on the charts. They also found that the flow in the eastern Cayman Sea, south of Cuba, is dominated by a large eddy.

The main implication of their findings is that things stay in the Caribbean longer than thought, implying that pollutants might have a greater effect, because it would take longer for circulating waters to flush them out. Other implications are less obvious. The Caribbean is a part of the North Atlantic Gyre, the grand clockwise circulation that includes the Gulf Stream. What happens here affects what goes on in the entire North Atlantic.

## SATELLITE TAKES EARTH'S TEMPERATURE

The first spacecraft built to test the feasibility of measuring variations in the Earth's temperature was launched from the Western Test Range, Vandenberg Air Force Base, Lompoc, Calif., aboard a Scout vehicle in April 1978.

Called the Heat Capacity Mapping Mission (HCMM), this experimental satellite will travel in circular, sun-synchronous 620-km (385 mi) orbit that allows for measuring midlatitude test areas of the Earth's surface for their minimum temperatures and then measuring those same areas' maximum temperatures about 11 hr later.

A two-channel scanning radiometer will acquire images in the visible and near-infrared spectrum during the day and in the thermal infrared spectrum both

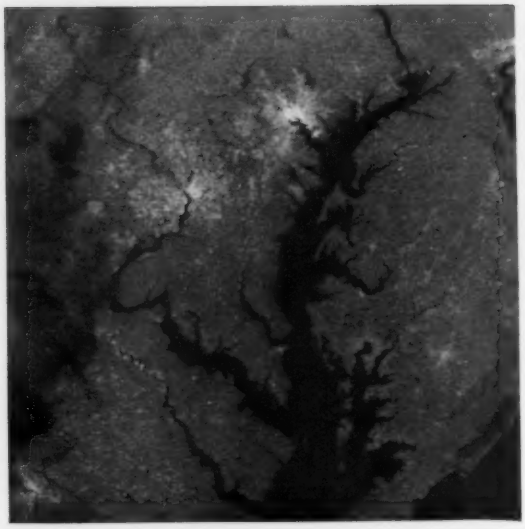


Figure 58.--This thermal infrared image indicated considerable temperature variation in the Washington and Baltimore area. The urban areas are hot (bright); small cities and roads (I-95) are apparent. The river basins show up because of moisture variation. The Appalachians show faintly in the upper left corner despite thin, cold cirrus clouds.

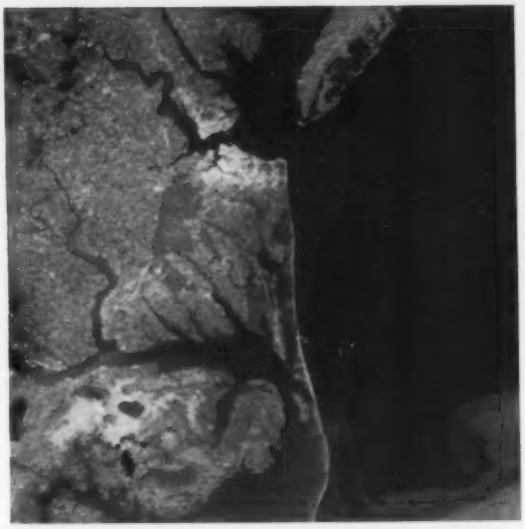


Figure 59.--A thermal image of the surface temperature contrast in the vicinity of Norfolk, Va., is hot (bright) due to urban heat island. The ocean and small clouds at the bottom are cold (dark). Note the eddy in the Gulf Stream and temperature gradients offshore and in the estuaries.

day and night. Resolution of the two channels will be about 0.5 by 0.5 km (1,800 ft) as the spacecraft acquires data along a 700-km-wide (435 mi) swath.

HCMM is the first of a series of low-cost, modular-design spacecraft built for the Applications Explorer Missions (AEM)--small experimental spacecraft in special orbits to satisfy mission-unique experimental data acquisition requirements. This mission was designed to allow scientists to determine the feasibility of using day-night thermal infrared remote-sensor-derived data for:

- Discrimination of various rock types and possibly locating mineral resources.
- Measuring and monitoring surface soil moisture changes.
- Measuring plant canopy temperatures at frequent intervals to determine transpiration of water and plant stress.
- Measuring urban heat islands (fig. 58).
- Mapping surface temperature changes on land and water bodies (fig. 59).
- Deriving information from snow fields for water runoff prediction.

HCMM data will be correlated with that received from other satellites, especially from Landsat, the Earth resources spacecraft, and with ground observations, to provide a better insight into detecting temporal temperature variations of the Earth's surface.

The spacecraft is unique in that its day-night heat measurement sequence permits readings of temperature changes associated with solar heating during the daytime and radiative cooling at night. This temperature difference is related to the properties of the surface layer approximately 5 to 10 cm (2 to 4 in) deep being measured. For instance, some types of rock such as shale have a wide day-night temperature difference, while other types of rock such as quartz have a smaller day-night temperature difference.

Test sites for HCMM measurements are located in various parts of the continental United States, western Europe, and Australia. Twelve American and 12 foreign investigators are participating in the program.

Some of the planned experiments are to:

- Discriminate among rock types and identify such features as subsurface faults or fracture not seen in the visible spectrum. For instance, some types of rock formations may emit similar radiation characteristics in the visible spectrum due to weathering erosion or silt cover, whereas the thermal spectral band, by measuring temperature differences, may indicate structural and compositional differences.
- Survey soil moisture of cultivated areas including some with extensive irrigation. For example, wet soils have a very low temperature variation during the day-night period, while dry soils and sand reach very high temperatures during the day and become quite cold at night.
- Determine whether plants are "running tempera-

tures" by observing the changes in temperature readings of the vegetated areas. When a plant has adequate water, its use of that water (transpiration) keeps it cooler than the surrounding air. A dehydrated plant exhibits a higher temperature, thus indicating plant stress.

- Map flood runoff and thermal effluents into coastal zones and the Great Lakes by measuring water temperature differences. Such data are expected to improve the monitoring from space of environmental and ecological disturbances to fresh and tidal water resources; i.e., animal, fish, and plant life.

- Study "heat islands"--concentrations of heat rising from large metropolitan areas. It is known that the higher temperatures associated with heat from cities can affect their local weather, but it is not known whether these higher temperatures can cause long-lasting changes in regional climates.

- Measure snow fields. Many areas of the country depend on melted snow for their water supplies. Other areas are threatened by floods caused by melting snow. Although snow field areas have been monitored for a number of years by Landsat and other satellites, HCMM should add improved temperature measurements to these snowmelt data and assist scientists in calculating the time and rate of snowmelt.

The orbit for the HCMM will permit measurement of near-maximum and minimum surface temperatures occurring during the diurnal cycle at about 1:30 p.m. and 2:30 a.m. in the middle northern latitudes. This orbit will also allow for reflectance measurements during daytime passes. From the nominal orbit altitude of 620 km (385 mi), the spatial resolution of the visible and thermal infrared radiometer channels will be approximately 500 by 500 m (1,840 by 1,840 ft). The ground swath of data coverage along the track will be 700 km (435 mi) wide.

The nearly polar sun-synchronous HCMM orbit will cover every area of the Earth's surface between latitudes 85°N and 85°S at least once during the day and once during the night within a 16-day interval. Both day and night passes over selected areas within 12 hr will repeat at 5- or 16-day intervals, depending on the latitudes of the areas.

## THE BLIZZARD OF '88

The following historical description was obtained from Robert C. Ratcliffe, National Geographic News Service. It makes the "Blizzard of '78" described on page 255 seem small by comparison.

When it comes to bad winter storms, the one you still hear about is the Blizzard of '88. In the annals of bad weather, that was the storm to beat. It caught the Nation unbuttoning for spring, and 400 died of cold and exposure, including 200 New Yorkers.

It touched the lives of one of every four Americans, survivors remembering for the rest of their days just where they were and what they were doing on "Blizzard Monday."

It isolated New York, Washington, and a dozen other major cities, and buried hundreds of towns and villages from Maine to Maryland under more snow than almost anybody had ever seen come down in a single storm. It marooned trains for days and wrecked ships by the hundreds.

Weathermen didn't see the disaster coming, but afterwards they figured out what had happened. There were two storms, cold winds and snow from north and west, and warm rainy winds pushing up from the South. By March 12, 1888, they had collided and were roaring up the East Coast as a blizzard, high pressure crowding it ashore and keeping it from surging out to sea.

The Blizzard of '88--forever capitalized in the mind by its fury--was the first disaster covered by the National Geographic. Everett Hayden, a Navy scientist, wrote in Vol. 1, No. 1, that the blizzard "drove the seas before it so violently that many tides did not resume their normal heights for nearly a week along coastal ports," and the Gulf Stream was shoved temporarily far to the south.

On land, the mildest winter in 16 yr was ending, there was talk of the upcoming baseball season, trees were budding, grass was sprouting, and Walt Whitman's new poem, "The First Dandelion," was in the March 12 New York Herald.

The blizzard hit Washington first and within hours the city was a frozen tangle of tree limbs, roofs, broken chimney tops, and telegraph wires. Wind and ice tore down all overhead lines between Grover Cleveland's White House, the Capitol, and government agencies. Trains arrived later and later and finally stopped coming. Washington was isolated.

It was the same story in Baltimore, Philadelphia, and across the six New England States, where towns were all but smothered by rooftop drifts.

On the water, 200 vessels were wrecked, beached, or sunk in Chesapeake Bay alone, where the violent wind briefly blew away the water, exposing the muddy bottom.

At sea, sailors swung axes to chop free icy rigging, but there was no way to fight the gales and huge waves. Dozens of ships foundered or were abandoned to drift dangerously for weeks across the Atlantic sea lanes.

The blizzard hit New York City hardest, with 75-mi/h winds howling through Manhattan Monday morning. Countless dramas of desperation soon began. The elevated railway stalled between stations, the passengers rescued by enterprising ladder bearers, often charging 50 cents a head for the climb down to safety. In Brooklyn, rescuers saved 20 mailcarriers who had collapsed unconscious into the snow while doggedly making their appointed rounds. Pedestrians stranded on the streets took refuge anywhere. Shopgirls, who feared losing their jobs and fought through the drifts to work, spent the night sleeping on the floor in front of their counters. Intrepid businessmen paid as much as $40 for a wagon ride to their offices. The stock exchange closed when only a handful of brokers showed up.

By the time the storm gave up, 21 in of snow had fallen on New York. That wasn't as much as the 25.8 in of the Big Snow of December 26-27, 1947, falling in half the time. But the Big Snow merely fell on the city. It didn't blast it with the blizzard winds of '88.

The snow-stricken shoveled themselves out, without the usual government disaster relief that now

eases the burden when their grandchildren find themselves victims of catastrophes. Washingtonians, however, got some help in the blizzard from a "poor fund."

The blizzard was a godsend for many immigrants who were paid 75 cents an hour to shovel snow--an estimated 20,000,000 $ft^3$. Stiff legs of frozen horses poked from drifts everywhere.

A favorite tale was about the department store buyer who made a killing on the snow shovels he had stocked by chance just before the blizzard.

The disaster was the making of family legends. For the rest of their lives many people born during the storm commemorated the twin events by wearing such names as "Snowflake," "Snowdrift," and even "Blizzard."

Some survivors banded together as the Blizzard Men of '88, and until only a few years ago there were still enough for annual get-togethers on the anniversary of the storm that Leslie's Weekly reported has left New York "like a forgotten ruin in the heart of Asia."

## CASUALTIES ABOARD U.S. COMMERCIAL VESSELS

A total of 6,140 ships were involved in 3,574 casualties during the 12-mo period ending September 30, 1977, according to a tabulation contained in a recent issue of the Proceedings of the Marine Safety Council. Storms or adverse weather were the primary cause of 298 casualties, and unusual currents were the primary cause of 30 more. There were 216 deaths and 136 injuries as a result of 133 ship casualties; one of these casualties was the result of collision in fog, resulting in one injury. Capsizings, founderings, and floodings constitute the category resulting in the highest number of casualties, 41, with 74 deaths and 15 injuries. Of the 133 casualties causing deaths and injuries, storms or adverse weather was the prime cause of none.

In addition to the above deaths and injuries, there were 272 deaths and 1,419 injuries aboard ships not involved in ship casualties. Natural causes accounted for 114 of these deaths, 77 persons fell overboard and drowned, and 3 deaths were primarily attributed to weather conditions. Sixty-five injuries were a direct result of weather.

Casualties involving commercial vessels are required to be reported to the U.S. Coast Guard whenever the casualty results in 1) actual physical damage to property in excess of $1,500, 2) material damage affecting the seaworthiness or efficiency of a vessel, 3) stranding or grounding, 4) loss of life, and 5) injury causing any person to remain incapacitated for a period in excess of 72 hr, except injury to harbor workers not resulting in death and not resulting from vessel casualty or vessel equipment casualty.

## SEASAT LAUNCHED

The first satellite built to observe the waves, currents, and ice movement of the oceans was placed in orbit around the Earth on June 27.

The $95 million satellite was launched atop an Atlas-Agena rocket from the Western Test Range at Vandenberg Air Force Base, Calif. Its orbit takes it over more than 90 percent of the Earth's oceans. The satellite is almost 500 mi high and follows a northern track that carries it over the same place on Earth every 36 hr.

Seasat will interest anyone with an interest in the sea. Oil explorers, shipping companies, deep-sea miners, fishing fleets, the world's navies--all will be fed data as it comes down from Seasat every 36 hr. In the data will be the heights of waves, lengths of crests between waves, speed of winds that sweep the waves, and the directions of the winds as they change.

Carrying the first civilian spaceborne radar to penetrate cloud and fog, Seasat will be able to monitor icebergs threatening sea lanes and to track ships threatened by storms. It will be able to measure windspeeds up to 50 kn and wind directions along a 2,000-mi corridor. Five instruments will map ocean tides and currents, measure depressions above ocean trenches, and record ocean surface temperature anywhere in the world to within 1 degree.

The prime focus of Seasat during its anticipated 1 to 3 yr of operation will be the Atlantic, where many of the world's ships are and many of the storms and accidents.

Assisting the United States in receiving and transmitting Seasat data will be Canada and Britain, both of them responsible for updating weather data on both sides of the North Atlantic. So precise will be the storm data Seasat picks out that it will be able to differentiate gales and hurricanes from the foam they generate on the ocean's waves.

## SCIENTISTS PROBE CONTINENTAL SHELF SEDIMENTS FOR INSTABILITY

NOAA scientists are probing the microscopic world of soil particles for clues to instability in continental shelf sediments--instability that can topple an offshore petroleum platform or wipe away an underwater pipeline.

In these studies marine geologists from the Atlantic Oceanographic and Meteorological Laboratories, Miami, Fla., are measuring such unconventional quantities as the amount of water between sediment particles (pore pressure) and the microstructure (fabric) of clay sediments. These properties determine the ultimate behavior of sediments under the loads imposed by offshore structures and passing storms. The measurements are attracting the attention of industry, now that so many national energy needs have begun to focus offshore.

Conventional methods of assessing sediment stability are performed on test sample sediments in laboratories ashore. The studies, however, measure pore pressure in sediments where they lie--in their pressurized, underwater environment.

In a 2-yr series of tests NOAA researchers have taken measurements in the shallow marine waters in heavily drilled shelf areas south of the Mississippi Delta, using a 65-ft (19 m), weighted cyclindrical probe. Deployed from a ship, it digs into the soft sediment floor, sensing pore pressure at three locations along its length. This information is recorded by equipment on a nearby oil platform.

The greater the pore pressure, the less effective the stress between particles, and the less stable the sediments. Thus, pore pressure can be a strong predictor of how sediments will perform under various loads.

Other studies on clay fabric samples taken from the same area reveal the particle-to-particle relationship in submarine sediments--a relationship that has not been explored much before. Clay fabric--the orientation and interrelationship of the sediment particles

themselves--determines the ultimate nature and physical properties of the seafloor deposit. One preliminary finding of this study is that the crystalline forms of the clay particles change their shape and orientation with depth of burial, becoming broader and more coherently alined.

The Delta area is ideal for this kind of sampling. It has high rates of sediment deposition there from the Mississippi River, so the sediment column is loaded rapidly. Because of the very fine grain of these sediments, the water does not squeeze out readily, and the pore pressure builds up. Also, the presence of methane gas in many of these sediments contributes to the unstable nature and complex behavior of the Delta deposits. Some rugged contours where massive blocks of sediments are sliding seaward, taking out underwater pipelines as they go, have also been found.

Passing storms can load the seafloor, cycling the pore pressures and sediments--and causing platform failures--with their wave and surge motion. When hurricane Eloise passed over one of the probes in 1975, the storm waves pumped the sediment pore water down to 114 ft below sea level.

The next step is to build a much larger self-contained probe for assessing sediment pore pressures at deep-water sites where exploration is pressing seaward.

These novel techniques, and such conventional ones as coring, acoustic profiling, and the like are converging on a series of highly detailed "site-specific" studies off the Atlantic coast. The geotechnical properties of entire blocks of continental shelf and slope are being defined to determine how stable sediments are in that potentially oil-rich offshore region.

It is desired to readily identify outer continental shelf areas that are potentially too unstable for the safe emplacement of structures and to provide reliable data for offshore engineering activities. These studies also provide insight into the geologic processes that shaped and are currently active on the continental shelf.

## LETTERS TO THE EDITOR

### LETTER OF COMMENDATION

The letter below was presented to Don Olson, Port Meteorological Officer, Seattle, Wash., by the U.S. Coast Guard in recognition of his efforts in promoting the AMVER program (fig. 60).

Figure 60.--Don Olson is on the right as Commander Andrew F. Hobson presents the letter of recognition. U.S. Coast Guard Photo.

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

16 January 1978

Mr. Don Olson
Port Meteorological Officer
National Weather Service
1700 Westlake Ave. N.
Seattle, Washington 98109

Dear Mr. Olson:

It is with great pleasure that I send you this letter of appreciation and recognition for the assistance and cooperation you have provided over the years in promoting the Coast Guard's AMVER program.

By visiting all the vessels arriving in the Puget Sound area in the normal pursuit of your duties and having personal contact with the Masters and Radio Officers of these vessels you have been successful in persuading over 300 vessels to become participants in this international lifesaving program over the past five years. This effort on your part has greatly assisted this District's AMVER Officer in the pursuit of his duties in promoting the AMVER program for the Coast Guard and has provided a valuable input to the Coast Guard's AMVER program.

On behalf of the Coast Guard I would like to extend our appreciation and look forward to your continued cooperation.

Sincerely,

G. O. THOMPSON
Rear Admiral, U.S. Coast Guard
Commander, 13TH Coast Guard District

Copy to:
Dr. N. Hull
Meteorologist-in-Charge
NWS Seattle, WA

## FAMILIARIZATION TRIP ON GREAT LAND

**The following report was submitted by Don Olson, Port Meteorological Officer, Seattle, Wash., on his familiarization trip from Tacoma to Anchorage and return during January 1978.**

The trip was made on the GREAT LAND, which is chartered by Totem Ocean Trailer Express, Inc., for fast and direct container van service to Anchorage, Alaska, from Tacoma, Wash. (fig. 61). The GREAT LAND is one of two ships of this company in this service. The ship's master is Captain Harold L. Small. The ship's physical dimensions are quite impressive: 888 ft long, 93-ft beam, average speed of 24 kn, and a carrying capacity of 550 containers/vans.

I boarded the GREAT LAND in Tacoma on Wednesday evening. Cargo loading began at 1900 and was completed by 0100; sailing time was set for 0300. The Puget Sound Pilot debarked at Port Angeles at 0800. We cleared buoy "J" at the entrance to the Strait of Juan de Fuca at 1030. Weather was excellent for a long-time landlubber like myself.

Upon departure from the Strait, Captain Small invited me to the bridge for a briefing. He encouraged me to make myself at home and to feel free to brief the deck officers in the weather observing program and to assist them in these duties.

During the first day the radio officer received radiofacsimile charts from NMC, KSFO. The FAX recorder is an Alden 11 marine FAX about the size of a portable typewriter. The ship's radio receivers are used for the recorder input. The charts received were of excellent quality. The best radio reception was on 12 kHz frequency. At times prior to receiving the signal from NMC, a radio teletype signal was quite dominant on this frequency. The radio officer says it's a Russian station transmitting. Later in the day we copied a broadcast from Esquimalt, B.C. The FAX copy was rather poor quality, although the signal strength was loud and clear.

Surface observations were begun at 1600 PST (27/0000 GMT). The deck officer on watch who takes the observation is usually the only one available on the bridge other than the quartermaster; it is very important that the observation not deter his other duties for the safe navigation of the vessel. The ship is equipped with a Weather Service barometer, marine barograph, and an F420C wind system. The F420C sensors are mounted on the upper radar platform some 40 ft above the bridge deck (fig. 62). The wind readout is mounted over the chart table (fig. 63). A sling psychrometer is used for the temperature sensors, the sea temperature is obtained from the engineroom intake temperature. A temperature check was made with the sea temperature by bucket during the trip, comparison indicated within 1/2 deg. Thirteen surface observations were transmitted during the trip, 11 were sent to NOJ, Kodiak, 1 to NMW, Astoria, and 1 to C7P. Average time of receipt was 15 min. As this vessel carries only one radio officer, the Weather Service has contracted to pay overtime for the 1200 GMT observation which falls between 0200 to 0400 ship's time during the trip. Three observations were sent as OT messages during the trip.

Weather during the northbound voyage was quite good. The maximum wind was only 36 kn from the southeast. The ship maintained excellent speed of 23 kn requiring Captain Small to slow the ship to make our ETA at Anchorage at 0500 Sunday morning at floodtide. At 2150 Saturday night we picked up the pilot at Homer, then proceeded to Anchorage arriving at 0500. Discharging began at 0700. Our departure time was set for 1700 that afternoon.

Felix Flara, part-time PMO at Anchorage volunteered his services on Sunday to provide me with a tour of WSFO Anchorage and some of the interesting parts of the city. The WSFO provided copies of the latest surface analysis and some progs for our return voyage.

The return voyage to Puget Sound was as scheduled with arrival at 1500 Wednesday, February 1.

Captain Small is very appreciative of all the weather information that is available on the radiofacsimile broadcasts from NMC San Francisco. He stated, "time means dollars saved in fuel consumption alone." By knowing the weather situation in the Gulf of Alaska on departure he can adjust the speed from 20 to 25 kn in order to make his ETA Anchorage every trip.

Figure 61.--A rather rare sunny day in the Gulf of Alaska enroute to Seattle on January 30, 1978.

Figure 62.--The radar mast over the bridge. Note the F420 wind sensors.

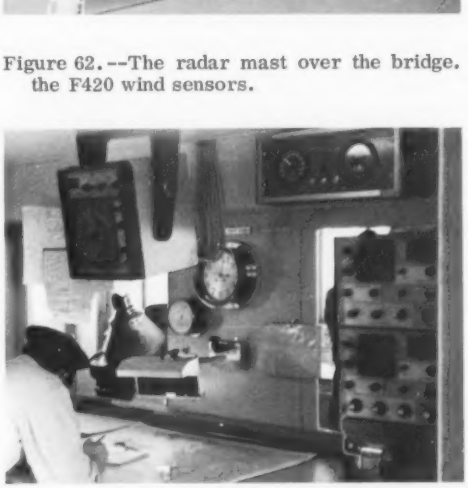


Figure 63.--On the bridge of the GREAT LAND. Note the F420 wind equipment readout over the chart table.

# MARINE WEATHER REVIEW

The SMOOTH LOG (complete with cyclone tracks [figs. 70-73], climatological data from U.S. Ocean Buoys [table 7], and gale and wave tables 8 and 9), is a definitive report on average monthly weather systems, the primary storms which affected marine areas, and late-reported ship casualties for 2 mo. The ROUGH LOG is a preliminary account of the weather for 2 more recent months, prepared as soon as the necessary meteorological analyses and other data become available. For both the SMOOTH and ROUGH LOGS, storms are discussed during the month in which they first developed. Unless stated otherwise, all winds are sustained winds and not wind gusts.

## Smooth Log, North Atlantic Weather

### January and February 1978

SMOOTH LOG, JANUARY 1978--There were fewer storms this month than normal. If wind were the only criterion, there would have been fewer storms to write about, but the winds produced high swell waves owing to long fetches. There were at least three storms that qualified for the monster of the month. The tracks were shifted northward and westward from climatology. The primary path of the centers was over and along the United States-Canadian east coast to the Denmark Strait where many dissipated. This was partially because of the influence of a higher-than-normal Azores High centered farther north than usual.

The Azores High was the prominent feature over the North Atlantic on the mean sea-level pressure charts. It was 1031 mb near 38°N, 30°W, compared to 1020 mb near 30°N, 20°W, according to climatology. The Icelandic Low was deeper than usual at 994 mb near 62°N, 32°W. This was 7 mb lower than normal and about 150 mi northeast of the normal position.

The higher pressure and northerly location of the Azores High produced a large positive anomaly center of 15 mb near 41°N, 32°W. The ocean area from coast to coast and latitudes 20° to 55°N was under the influence of this positive anomaly center. The major negative anomaly had an 8-mb center that covered the area between Iceland and Greenland plus the ice cap.

The upper air gradient was also more intense than usual with a low center over Baffin Island and a high center south of the Azores. A very sharp trough paralleled the U.S. East Coast near the position of the Appalachian Mountains. The zonal flow then traveled northeastward toward northern Europe. The same large area of positive anomaly dominated that part of the ocean of major interest to shipping.

Extratropical Cyclones--A LOW had moved northeastward up the North American east coast. On the 2d it was south of Newfoundland. Another center formed to the southwest in a weak trough trailing the LOW. The second center quickly developed and on the 3d was the primary storm. The MORMACSUN was east of Hatteras headed toward New York with 20-ft seas on her bow. The CETRA CARINA (39°N, 50°W) was fighting 60-kn southerly winds. Later in the day a ship near 45°N, 44°W, had 25-ft seas with a thunderstorm along the front. At 1800 the BRONISLAW LACHOWICZ near 39°N, 69°W, south of Nantucket Island reported 72-kn west-northwesterly winds. At 0000 on the 4th, the 960-mb LOW was near 55°N, 53°W. At noon the CETRA CARINA had 50-kn winds on her starboard. Not far away a ship found 20-ft swells.

The storm was heading for Kap Farvel, but on the 5th it turned southeastward as a small LOW moved along that side. Three Soviet ships in the Labrador Sea reported northerly 50-kn winds with 30-ft seas. At 1200 the INDIGUIRKA near 56°N, 47°W, had 55-kn winds and 28-ft seas on her starboard quarter. A ship south of the center was pounding into 30-ft swells.

On the chart of the 6th, the new low center became the primary center west of Iceland at 967 mb. Seas and swells of 20 ft were still being observed along 55°N. On the 7th the storm was over the Greenland Sea.

On the 8th a polar front with a frontal wave lay across the southern states with a weaker arctic front across the northern states. A large 1053-mb HIGH was over western Canada feeding very cold air over the eastern half of the United States. This cold-air push rapidly drove the arctic front southward with cyclogenesis near Lake Huron. By 1200 on the 9th a 975-mb LOW was near Ottawa with strong southerly flow off the East Coast.

This was one of the worst storms for the eastern United States this year. Strong cold winds drove the wind-chill temperature to as low as minus 48°F at Chicago. Actual overnight lows of minus 20° to 30°F were common in the Plains States. Temperatures dropped into the 30's in southern Florida. In Ohio and Cleveland National Guardsmen were called out to rescue stranded motorists. There were power outages and shortages in many areas. Ships and coastal areas all along the East Coast had problems. On Narragansett Bay of Rhode Island 60 families were evacuated. In Portland, Maine, the family that manned the light station at Goat Island was forced out by rising water.

The U.S. Coast Guard cutter PT. JACKSON encountered 10-ft seas with winds gusting to 70 kn off Massachusetts while towing the disabled dragger ZIBET. Bridges and wharves were destroyed. Many

ships and barges had problems. The 24,471-ton tanker ACHILLES ran aground in Narragansett Bay. The barge BOUCHARD 100 with 27,000 barrels of fuel sprang a leak in Huntington Bay, Long Island. Efforts to contain the leak were hampered by 10-ft waves and severe winds. The tanker TULSA GETTY dragged anchor and grounded in Delaware Bay. High tides caused severe damage all along the coast. The tug ROYAL LADY capsized and sank in Port Royal Sound, S.C., while pushing barges. One crewmember of four survived.

Many ships off the U.S. East Coast reported winds of 45 to 55 kn. Waves up to 44 ft were reported. On the 9th the MOBIL FUEL was about 450 mi east of Norfolk (38.5°N, 71.2°W) with 50-kn winds and 41-ft seas. The KING RICHARD was sailing southeastward near 35°N, 72°W, into 54-kn southerly winds driving 31-ft seas and 26-ft swells with a thunderstorm. There were many reports of winds of 50 kn or greater on the 10th as the 956-mb storm moved northward. The J. LOUIS near 38°N, 65°W, reported 41-ft swells. The EASTERN SUN near 37°N, 67°W, was hammered by 55-kn winds, 20-ft seas, and 44-ft swells. On the 11th the LOW was over Davis Strait, but there were still 25-ft swells as far south as latitude 35°N. High pressure centered near 45°N blocked easterly movement of the storm. Two French ships, the CETRA CARINA (39°N, 64°W) and PENHIR (39°N, 50°W), caught 64- and 54-kn winds. On the 13th the storm died near Thule.

As the first storm of the month moved into the Greenland Sea on the 7th, a LOW formed near the southeastern coast of Greenland. It remained stationary until the 9th, when it started an easterly movement. Seas and swells of 20 to 25 ft were reported generally south of Ocean Weather Stations Charlie and Lima. On the 10th the 982-mb center was between Iceland and the Faeroe Islands. OWS Lima measured 45-kn winds and 26-ft swells. At this time the center turned southward over the North Sea. The Azores High persisted near 40°N, 30°W. The KHIBINSKIE GORY had 50-kn winds and 20-ft seas near 47°N, 11°W, while Ocean Weather Station Romeo to the west near 17°W had 26-ft seas. The STRATHASLAK south of Bishop Rock was pounded by 50-kn winds, 25-ft seas, and 36-ft swells. The LNG tanker ARIES broke adrift from her moorings at Canvey Island in storm-force winds at flood tide late on the 11th. She dragged anchor and moorings causing four barges to set adrift with one capsizing. A dredge capsized at Dieppe, France. One of the two men aboard drowned. At Dunkirk, the French 12,224-ton PORT NAVALO and 11,543-ton TOURS were damaged. Winds gusted to over 65 kn. The EXPORT PATRIOT (48°N, 09°W) had roaring 65-kn winds and 20-ft seas. Romeo had 25-ft seas into the 12th. The HIGH was pushing northward with a ridge extending into the Greenland Sea. As the LOW moved into Germany, the center jumped the Alps to reform over the Ligurian Sea.

Even though the LOW was now over the Mediterranean, there were still strong north to northeasterly winds over the North Sea as the HIGH was now 1042 mb near 49°N, 19°W. These strong winds caused the 3,000-ton Swedish freighter FENIX to shift cargo and develop a 30° list while north of the Dutch island of Terschelling. Also, the 9,326-ton Greek freighter TANAGREA had weather problems 20 mi south of Umuiden. The Panamanian freighter EASTERN UNITY (9,505 tons) requested assistance near Cherbourg, and the 21,050-ton Greek AEGIS BALTIC went aground in the Scheldt but was later refloated.

This was really a coastwise storm. It developed on the 12th off Brownsville, Tex., and followed the coast to Labrador, Canada, on the 16th. When the 994-mb storm was near Atlantic City on the 14th, a SHIP near 36°N, 71°W, was battered by 41-ft seas. The persistent Azores High, centered between the Azores and Newfoundland, blocked eastward movement of the storm as it followed a northeasterly track to Kap Farvel. The SEA-LAND GALLOWAY at 1200 on the 15th near 42°N, 60°W, had southerly 48-kn winds with 36-ft seas. The SEEADLER was 15° latitude south of the LOW with 55-kn winds and 25-ft waves. Late on the 17th the JOHN CABOT (51°N, 53°W) had 60-kn winds. As the LOW moved south of Iceland on the 18th and 19th, wave reports of 25 ft were common between 45° and 55°N. Romeo measured 33-ft waves on the 19th with 50-kn winds. The 15,351-ton French ATLANTIC COGNAC, Southhampton for New York, arrived Brest on the 20th for deck repairs from heavy weather damage. A French ship had 50-kn winds, 30-ft seas, and 33-ft swells off Fastnet Rock. The GORNY SLASK reported 85-kn winds, 23-ft seas, and 25-ft swells with thunderstorms in the Bay of Biscay. On the 20th Romeo had 39-ft seas and Lima 20-ft seas with 34-ft swells. Another LOW had developed to the southeast, which moved over the United Kingdom and dissipated.

The Azores High was still sitting firmly over the central ocean, when a cyclone formed over the Carolinas on the 18th. The storm was bringing southeasterly winds heavily laden with moist snow ahead of the center. The New England coastal states were heavily hit. In Brookville, N.Y., the auditorium roof of C.W. Post College collapsed from an accumulation of snow, sleet, and rain (fig. 64) on the 21st. From the 18th to the 21st

Figure 64.--A lone man, lower foreground, stands by the collapsed dome of the auditorium at C.W. Post College in Brookville, N.Y. The doomed roof was 22 ft high. The building was empty, and there were no injuries. Wide World Photo.

record snow and precipitation caused the collapse of many buildings. The LOW moved up the Atlantic coast and was 992 mb over St. John's at 1200 on the 19th. Ship reports indicated only gales. Twenty-four hours later it was 964 mb southeast of Kap Farvel. Three ships along the trailing front reported 23-ft seas and/or swells with gales. On the 21st the 956-mb LOW had turned toward Kap Farvel. The SELFOSS as well as several other Icelandic ships reported 50- to 60-kn winds. Ocean Weather Station Romeo again had seas of 26 ft, while Charlie suffered 23 ft. Other ships south and west of them were reporting the same. The LOW stalled near the Greenland coast, where it slowly filled. Several frontal waves moved around the southern periphery. One brought 60-kn winds and 25-ft waves to the DELTA DRECHT near 47°N, 24°W. Not far away the C.P. DISCOVERER was sailing into 33-ft swells. The LOW disappeared late on the 23d.

Monster of the Month--This was a Gulf Coast storm, but it tracked inland on the west side of the Appalachian Mountains. Late on the 25th (2100Z) the MOBIL ENGINEER was about 160 mi southeast of Cape Hatteras with 50-kn winds from the southeast and 16-ft waves. On the 26th a weather forecaster in Massachusetts reported that the temperature rose 18°F in just a few minutes. A ship heading south near Cape Hatteras plotted 51-ft seas. The Coast Guard cutter HAMILTON reported 65-kn winds near 40°N, 72°W. The EDGAR M. QUEENY had 65-kn winds off Cape Hatteras, and the MONTICELLO VICTORY, east of

Figure 65.--This house and bus are buried in deep, drifting snow in Indiana. U.S. Air Force Photo.

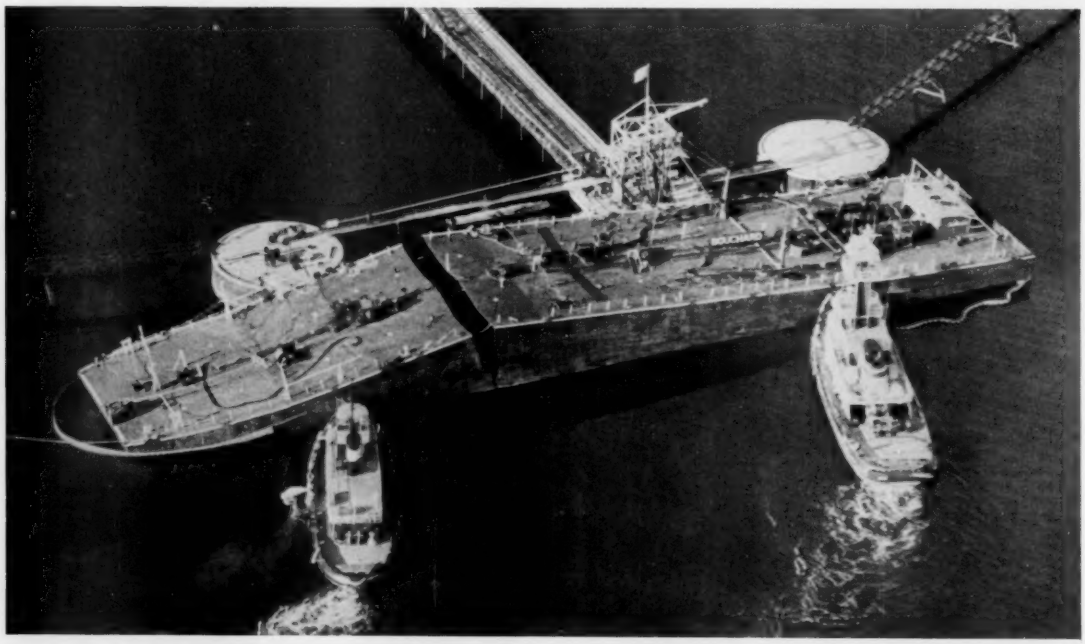


Figure 66.--The 340-ft oil barge BOUCHARD 105 holding 1 million gallons of fuel oil lies split at Newington, N.H. Wide World Photo.

Savannah, had 60-kn winds and 28-ft seas. Four ships on the Great Lakes measured winds over 45 kn. After the storm center passed over the Great Lakes, two centers formed on the 27th with the easterly one surviving. In the early morning on the 27th, a tornado hit Stafford County, Va., killing a young boy and damaging many houses and trailers. Rain and melting snow caused rivers to flood in the East. In the Midwest snowfalls of 7 to 17 in with winds gusting to 70 mi/h brought snow drifts in Ohio and Indiana of 5 to 6 ft. A passenger train in Indiana was stranded in a snow bank for more than 12 hr (fig. 65). In Ohio 150,000 people were without power and heat, and over 5,700 motorists were rescued from stranded vehicles with over 2,000 beyond reach. The BURTON AYERS on Lake Erie and set in ice off Peele Passage measured 98-kn winds at 1200 on the 26th. An automated station at the Cleveland Crib recorded 89 kn, and a bridge near the harbor was blown down. The storm was called the "worst blizzard of the century" with drifts up to 25 ft deep. Fifty-one people were killed.

All-time low-pressure records were broken. Cleveland, Ohio, recorded the lowest of 28.28 in (957.7 mb). Detroit, Mich., and Erie, Pa., had 28.34 in (959.7 mb); and Columbus, Ohio, recorded 28.47 in (964.1 mb). On the 27th storm warnings were still posted for the Lakes.

A ship off Cape Hatteras had 24-ft seas on the 27th. A few hours later another ship verified that report. Late on the 28th the LOW moved over the Labrador Sea. The HUDSON was off Hamilton Inlet with 50-kn winds. On the 29th the LOW broke up on Kap Farvel, but another formed east of Long Island maintaining the strong, cold northwesterly flow over the warmer water. Late on the 30th the 340-ft oil barge BOUCHARD 105 split in half at Newington, N.H. (fig. 66).

A frontal wave moving across the top of the HIGH developed into a LOW on the 26th. As it moved eastward, another center formed at the point of occlusion off Ireland on the 27th. Since there was a circulation already established, it developed quickly. At 1200 OWS Romeo had 30-ft seas, and at 0000 on the 28th they were 39 ft. A ship coming out of the English Channel fought 60-kn winds. The HANNOVER was off Brest with 52-kn winds and 33-ft seas and swells. The storm was over the English Channel on the 29th, and many ships were reporting 50 to 60 kn. Coastal weather stations were measuring 40-kn prevailing winds. On the 30th the storm moved over Scandinavia.

This storm wrecked havoc in Europe from the Riviera to Scotland. It was described as the worst storm in England in 30 yr. At least eight persons died, and many were missing as a result of the storm. In northern Scotland wind drove the snow into drifts as high as 45 ft. The winds, snow, and rain brought chaos to the area. Avalanches and snow slides took three lives. One man died in northern Ireland, when strong winds blew him off his feet and into the water. In north Wales a climber drowned in a mountain lake after slipping. In Europe early reports indicated at least 19 people died and hundreds were stranded and/or missing. In Italy a bridge collapsed, and three were drowned when their car plunged into the river. In Yugoslavia powerlines were blown down, and winds along the coast caused mountainous seas which sent spray soaring 20 m into the air as the seas pounded the cliffs. Along the Riviera gale-force winds, rain, and snow blocked train tracks and highways. Rain, wind, and tides flooded Venice. Spanish officials feared that 27 crewmembers of a 36-man crew of a trawler were drowned. The 1,317-ton MARBEL ran aground off Vigo when caught by 55-kn winds.

Casualties--The 4,226-ton Panamanian LESLIE B. radioed the Coast Guard at Halifax on the 2d that she was taking on water from heavy seas and in danger of sinking. Four additional dewatering pumps were delivered to control the flooding. The 10,029-ton Turkish KOYCEGIZ arrived New Orleans from the Mediterranean on the 2d with heavy weather damage. The Singapore freighter SAVANNAH (8,893 tons) was adrift in bad weather with engine trouble on the 4th off Algiers. The Liberian cargo vessel NANFRI (19, 226 tons) reported heavy weather damage upon arrival at Genoa on the 4th. The 2,032-ton Greek KYRA ELENI ran aground in heavy weather near Gaidaro Island and sank on the 6th. The crew was saved. The 9,190-ton GREGOS arrived Durban from Trinidad with heavy weather damage on the 9th.

The Liberian-registered cargo vessel MAIRA (9,483 tons) arrived Algiers on the 9th with several containers lost when they shifted in heavy weather. The lash barge PL-1-0531 sank near Bandirma jetty in Turkey, when it was caught in a sudden storm and the holds flooded. The American hydrofoil FLYING PRINCESS collided with the motor tank barge DUTCH COURAGE in dense fog while enroute to London on the 18th.

The British tanker SILVERPELERIN (4,474 tons) arrived Nova Scotia on the 18th with heavy weather damage incurred on the 15th. The 30,000-ton laker JAMES R. BARKER arrived Chicago with self-unloading equipment damaged, which was probably caused by frozen ore. The 1,851-ton Greek MARLEN was abandoned in heavy seas on the 21st near 30°N, 11.6°W. The crew was rescued. A later search for the vessel was conducted, but no trace was found. The Greek steamer TOLMIDIS (9,481 tons) reported taking on water and was abandoned by the crew 60 mi off the coast of North Carolina on the 22d. On the 26th the 9,841-ton Liberian EVA MARIA sank in heavy seas near 22.8°N, 92.7°W, after explosions onboard. The crew reached the drilling rig SEDCO 135. The SEA-LAND RESOURCE was surveyed at Rozenburg on January 4 for heavy weather damage in December.

Rivers in the Midwest were generally frozen except for large ice floes which would break loose and hinder navigation. Late in the month huge ice floes broke loose above the Markland Dam in the Ohio River. Seventeen barges broke loose above the dam and sank the tug CLARE E. BEATTY. A submerged ice floe tipped the tugboat's bow 35 ft above the water, and she was crushed by a 300-ft by 52-ft barge. Five barges were piled against the McAlpine Dam, and 12 barges and an entire marina of boats were heading for the Connelton Dam. A 50-mi section of the Ohio River along Indiana and Kentucky was closed because of one giant ice floe with about 40 ft showing above the waterline.

SMOOTH LOG, FEBRUARY 1978--The paths traced by the low-pressure centers this month differed radically from climatology. There were fewer storms than normal over the United States, but a nearly normal number over the seas. There were more storms than usual over the Mediterranean Sea, particularly the eastern half. Most of the LOWs formed over water rather than tracking over the land. The primary average track was from Cape Hatteras to 45°N, 40°W, where the storms dissipated or turned sharply north-northeastward. Several storms tracked onto the continent.

The Icelandic Low at 991 mb near 49°N, 36°W, was 12 mb lower than normal and 600 mi south of its usual location. The Azores High was 1019 mb near 24°N, 27°W. This was 1 mb lower than normal and 300 mi to the southeast. A large 1029-mb High was firmly entrenched over central Canada and affected both North Atlantic and North Pacific storms.

The deep LOW and abnormal position produced a -19 mb anomaly center near 48°N, 35°W. The ocean north of 20°N was influenced by this large anomaly. There were three positive anomaly centers across the north country--a +9 mb over central Canada, a +13 mb over northern Baffin Bay, and a +14 mb near Scoresby Sound.

The upper air circulation was influenced likewise by the misplaced pressure/height centers. A low center to match the climatological center was over the Queen Elizabeth Islands, but the main circulation center was near 50°N, 40°W. The surface High over Canada was reflected in the upper air by a sharp ridge over the Rocky Mountains. A weak ridge was evident over the European west coast. There was a large negative anomaly over the central ocean and a large positive anomaly over northern Canada.

Extratropical Cyclones--A large area of weak low pressure was centered south of Newfoundland on the 1st. By 1200 there were three centers, with the one of interest near 37°N, 60°W. At 0000 on the 2d, the ESCHERSHEIM was about 370 mi southwest of the center battling 60-kn winds. Far to the north just north of St. John's and one of the other centers two U.S.S.R. ships fought 50-kn plus winds. At 0600 the GARINDA (38°N, 49°W) had 64-kn winds, and at 1200 the EXPORT COMMERCE (38°N, 42°W) was battling squalls and 31-ft swells.

At 1200 on the 3d the storm was 974 mb centered near 54°N, 35°W. The IDEFJORD about 250 mi southeast of the center was fighting 60-kn winds and 43-ft seas. About 350 mi to the southwest the C.P. DISCOVERER also fought 60-kn winds with 33-ft seas and 39-ft swells. The C.P. VOYAGEUR reported at 1138 on the 3d that a 20-ft container was lost overboard while 1,000 mi east of St. John's, Newfoundland. Six hours later a ship (50°N, 35°W) estimated 60-kn winds, 33-ft seas, and 49-ft swells. The IDEFJORD was still wallowing in 43-ft seas on the 4th, but the winds had dropped to 50 kn. As the 973-mb LOW moved north of OWS Lima on the 4th, she had 23-ft waves, and two ships as far away as 900 mi to the south-southwest had 25-ft waves. The DISCOVERER reported at 1353 on the 4th that five 20-ft and four 40-ft containers were lost overboard. The waves at Lima dropped to 20 ft on the 5th as the storm weakened south of Iceland. On the 6th it dissipated on the coast of Iceland.

Monster of the Month--This was a Cape Hatteras storm. A small 1012-mb circulation was analyzed on the 0000 chart of the 6th with the aid of buoy 41002. At 1800 the SOLIMOES (33°N, 77°W) had northerly 60-kn winds off Wilmington. The YOUNG AMERICA was about 420 mi off Cape May fighting 65-kn winds and 20-ft waves. The LOW was following the coast, and the northeasterly circulation was bringing more snow to the embattled northeast as far west as the Great Lakes. On the 6th the storm brought 58-kn winds to the Meteorological Observatory in Blue Hill, Mass., 69-kn winds to Boston, Mass., and 114-kn easterly winds to the Mt. Washington Observatory in New Hampshire, which is 6,262 ft above sea level. The strong onshore winds caused heavy beach and shore erosion with coastal flooding from New York northward. Cape Cod measured 80-kn winds. The entire northeastern United States was paralyzed with deep snow and drifts. Twenty to 30 inches of new snow was common and blowing into huge drifts. Tides were running 2 to 6 ft above normal. Record high tides of 14.7 and 14.3 ft were measured at Boston, Mass., and Portland, Maine, respectively. Higher unofficial tides were reported at other locations. Thousands of people were forced out of their seashore homes by high water and waves. In Massachusetts alone 2,100 houses were destroyed and 10,000 damaged. Record cold temperatures reached into Florida as northerly winds plunged southward west of the LOW.

A new 24-hr snowfall record of 22 in was recorded at Boston. New York City had a total of 17 in for the heaviest snow in 30 yr. On Route 128 near Canton, Mass., some 2,500 stranded vehicles including 500 trucks clogged an 8-mi stretch of the highway. A statewide ban on nonemergency driving was imposed in Connecticut and Massachusetts. National Guard and Federal troops aided in rescue and patrolling operations. Airports were closed and bus and rail traffic came to a virtual standstill. Roofs of buildings collapsed from the weight of heavy wet snow.

At 0000 on the 7th the YOUNG AMERICA (39°N, 65°W) was east of the 984-mb center and sailing into 65-kn easterly winds with 25-ft waves. Twenty-four hours later they were 30 ft. A ship and a Coast Guard cutter off Cape Cod had 50- and 55-kn winds. At 1200 a German ship near 38°N, 62°W, reported 72-kn winds and 26-ft seas and swells. Other ships south and east of the center had 50- to 60-kn winds and 20- to 25-ft waves. The 38,889-ton Greek tanker GLOBAL HOPE (fig. 67) was blown aground at Massachusetts Bay. Five men aboard the pilot boat CAN DO, which went to the aid of the tanker, were lost.

Figure 67.--The Greek tanker GLOBAL HOPE is aground on shoals off Salem, Mass., in the wake of this storm. All the crew were rescued. Wide World Photo.

On the 8th the storm was moving eastward but still bringing snow and winds to the northern New England coast. The H1070 had 50-kn winds, 30-ft seas, and 36-ft swells off Cape Sable. Several other ships had winds in the 50-kn category with seas to 25 ft. At 1200 on the 9th the 980-mb storm was east of Newfoundland and turning northward. The ATLANTIC CONVEYOR and ALMERIA STAR were southwest and southeast of the center, respectively, with 30-ft swells.

On the 10th the storm was moving westward and crossed the Labrador coast on the 11th. It then turned southward and eastward to disappear over the Gaspe Peninsula on the 13th.

See the article "Blizzard of '78" on page 255 of this issue for an additional description of this storm.

A LOW out of the Gulf of Mexico moved across Florida on the 9th. It tracked east-southeastward, and a ship found 50-kn winds 300 mi south of the center on the 10th. Later in the day the storm developed multiple centers along the track and a trough that stretched southwestward. On the 1200 chart of the 11th, a center was analyzed near 32°N, 67°W. By midday on the 12th it was obvious that this was developing into the primary storm as the central pressure plunged to 970 mb. Among the half a dozen ships that reported winds of 50 kn or more, the ones with the highest seas and swells were in the southwest quadrant. They were the BISCHOFSTOR (39 ft), ERLANGEN (36 ft), and MORMACSEA (30 ft).

On the 13th the EXPORT LEADER and DEDA were within 50 mi of each other near 39°N, 57°W, with 25- to 30-ft seas and swells. At 1200 the storm was whirling about 42°N, 47°W, at 956 mb. There were now eight reports around the storm of winds of 50 kn or greater. The highest was 88 kn with 26-ft waves by the BISCHOFSTOR (30°N, 60°W) about 1,000 mi southwest of the storm's center. Other ships including the SOLON TURMAN were tossed by 33-ft swells. The 7,046-ton Pakistani cargo vessel AL KULSUM bound for New York experienced heavy weather 1,300 mi to the southeast. Late on the 13th, a second LOW center formed in the southwest quadrant. This tightened the pressure gradient south of the centers. The gradient was also tightening to the north as a 1046-mb HIGH sat over Baffin Island. Ships north of the center found 50- to 60-kn northeasterly winds and waves to 30 ft.

Late on the 13th the HIGH was retreating westward as the LOWs moved northward. On the 14th winds of 70 kn were reported both north and south of the storm's center. The British tanker IRVING STREAM reported two bollards torn off at a wharf in St. John's, Newfoundland, with 50-kn northeasterly winds and freak undertow early on the 14th. The lines of a cargo schooner parted and it collided with a fishing vessel which became fouled in another ship's lines. On the 15th the USNS COMET reported 91-kn winds east of the two centers which were approaching each other to merge on the 16th. The DART AMERICA was hove to at 1000 on the 15th when the pressure dropped to a minimum of 950 mb. The winds in the ship's log were northwesterly at force 11-12. A note on the

barogram indicated that the winds reached 85-kn near 45.5°N, 38°W. The vessel was pitching and rolling heavily in very heavy seas and swells and shipping water and spray overall. The NORTHERN was off Kap Farvel with 39-ft seas. The 5,000-ton German tanker ALCHIMIST ran aground in rough seas 30 mi north of Lisbon on the 16th. Helicopters rescued 7 of the 13 men in the crew. The remainder stayed aboard. A Portuguese Navy frigate stood nearby, but its rescue operations were hampered by 12-ft waves. In the meantime another low center from the vicinity of Cape Hatteras was racing eastward under zonal flow south of the main LOW. It was creating gale-force winds and swells up to 25 ft. The primary LOW was stationary near 49°N, 38°W, until the 18th. Winds in the 50-kn range were blowing in all quadrants with isolated reports of waves up to 33 ft. Most were in the 20-ft range.

By the 18th the peripheral LOW had curved around and into the center of the circulation, and the old LOW started to slowly drift eastward. The NEW ZEALAND STAR was pounded by 33-ft waves near 37°N, 36°W. On the 19th the new center became the primary circulation center, but this mattered little to ships fighting the high winds and waves. The SAMUEL CHASE, 400 mi south of the 972-mb LOW, had 55-kn westerly winds, 25-ft seas, and 39-ft swells. On the 20th the LOW moved westward and weakened rapidly over the Labrador Sea. In the meantime all was not quiet on the eastern front. On the 18th the front was approaching the European coast, and a LOW formed at the point of occlusion south of Ireland. Snow and ice paralyzed large areas of northwestern Europe. One of the worst snowfalls in 30 yr hit southwest England with up to 18 in. Gales drifted the snow into 20-ft drifts. Roads and railroads were blocked and thousands were without electricity as powerlines were downed. At least 100,000 people were without water because of power loss, and 600 schools were closed. In northern France the extreme cold killed two people. A quarter of a million people were without electricity as powerlines and concrete pylons snapped in the cold. Temperatures dropped to -15°C. In Paris the International Airport was closed owing to snow and ice on the runway. About 2.5 in of snow fell on the city, the third snow in a week where normally only about two occur in a year. In Denmark the mercury fell to -25°C. Stockholm was hit by 2 ft of snow, and hurricane-force winds lashed the west coast of Norway. Nine fishermen were missing after their ship sank late on the 18th. Northern Poland suffered blizzard conditions. Thick ice covered the bays of the Baltic Sea coast, where icebreakers were required to keep ships moving.

Another storm was moving into the circulation from the southwest. The original LOW became stationary near Anticosta Island on the 23d. It was very stubborn and survived to move eastward again, but it disappeared east of Newfoundland on the 27th.

There was a series of three frontal waves on a weak front that paralleled the U.S. East Coast on the 18th. The center one survived to become another severe storm. The LONG BEACH was west of the 984-mb center (41°N, 56°W) with 50-kn winds on the 20th. At 0000 on the 21st, the MUENCHEN was near 40°N, 45°W, about 300 mi southwest of the 969-mb center, with 60-kn winds and 39-ft seas. The SAMUEL CHASE was sailing from one storm into another. She was battered by 64-kn winds, 20-ft seas, and 41-ft swells near 44°N, 46°W, in this storm. At 0600 the DORDRECHT (41°N, 41°W) had 52-kn winds and 31-ft seas and swells on her stern. At 1200 the SEALAND GALLOWAY was 1 of 10 ships that reported winds of 50 kn over or around the storm. Her report of 50-kn winds and 41-ft seas was from 41°N, 35°W, directly south of the 970-mb storm. There were reports of waves of over 20 ft as far as 900 mi from the center around the southern hemisphere of the storm. These continued into the 22d. At 1200 the BORNHEIM was near the Azores Islands with 60-kn winds and 41-ft seas and swells.

Another low center had formed north of the original one and on the 23d became the primary storm and tracked northward. This brought strong southeasterly winds to the North Sea. Winds of 50 to 60 kn and seas to 30 ft pounded shipping and platforms. This lasted into the 24th, when the new storm also disappeared from the analysis.

The frozen tundra of Canada north of Lake Winnipeg produced this LOW. In 2 days it plunged south to southern Missouri where it turned eastward. The center crossed the Carolina coast about 0300 on the 22d. At 1800 the USNS COMET was near 32°N, 75°W, with 50-kn winds and 20-ft waves. At 0000 on the 23d the 980-mb LOW was near 38°N, 59°W. The GREEN HARBOUR (35°N, 57°W) fought 55-kn winds and 26-ft waves on her bow. At 1200 the OLIVIA MAERSK at 36°N, 53°W, had 60-kn winds and 23-ft swells on her bow while about 400 mi south of the storm's center. Late on the 23d the AMERICAN LEGEND on a westward track sailed almost through the center of the storm, recording a pressure of 951 mb along with 60-kn easterly winds (fig. 68). On the 24th the storm overtook the AMERICAN LEGACY with a low pressure of 964 mb, and her pressure remained near 970 mb for the next 48 hr as she moved eastward with the storm.

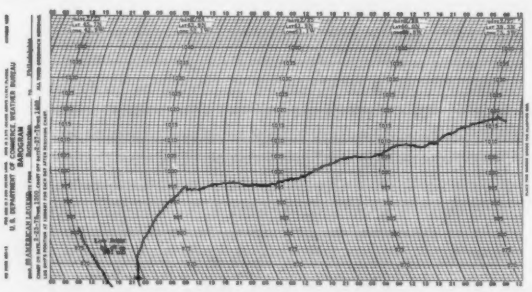


Figure 68. --The barogram from the AMERICAN LEGEND.

By 1200 on the 24th, the storm was 944 mb near 48°N, 37°W. The BRUNSHAUSEN (36°N, 37°W) battled 52-kn winds and 49-ft swells. At 1800 two ships, the ACAVUS (45°N, 36°W) and CHESHIRE (43°N, 38°W), had hurricane-force 70-kn winds. The latter had 41-ft seas and 66-ft swells while the former had only 26-ft seas and 49-ft swells. Six hours later at 0000 on the 25th the STEPHANITOR near 42°N, 37°W, or about 500

mi southwest of the 942-mb center, was sailing with 52-kn winds, 33-ft seas, and 46-ft swells on her stern. Later in the day the ZEALANDIC, which was near 41°N, 20°W, reported 57-ft swells on three observations. The MORETON BAY (43°N, 21°W) joined in with 59-ft swells on the 1800 observation. Winds of 50 kn and waves over 30 ft continued through the 26th.

Minor LOWs and troughs were moving around the southern part of the circulation as the primary LOW split into several centers. The central pressure was rising and the winds and seas were decreasing. On the 27th one of the new LOWs became the primary center which deteriorated on the 28th, but another center carried the now minor storm into the Norwegian Sea.

A weak, flat high-pressure area was centered over the Ohio River Valley on the 27th. The large low-pressure area described above was over the eastern ocean and breaking down with minor LOWs and troughs between. A weak 1007-mb LOW was analyzed over Maine and New Brunswick. It moved southeastward and intensified over the warmer water. By 0000 on the 28th it was 980 mb near 42°N, 52°W. The CARCHESTER was within 2 mb of the center with 45-kn winds. As the LOW turned northeastward, the CHESHIRE near 40°N, 52°W, was headed into 45-kn winds and 30-ft swells. On March 1 the LOW had deepened to only 976 mb, but its area of cyclonic influence had expanded many times. The ILLYRIC was in the vicinity of 38°N, 42°W, with 50-kn winds on her port quarter. The seas were 33 ft and swells 21 ft. At 1800 the seas were 33 ft and swells 41 ft. On the 2d the highest values on the communication circuits were 60 kn and 21 ft. Late in the day the LOW split into two centers, and on the 3d these disappeared as another major storm extended its influence.

Casualties--The British barge FEDERAL 400-2 carrying the jack-up drilling rig ORION went aground in high winds and waves on Guernsey in the Channel Islands on the 1st after the tow broke from the tug SEEFALKE (fig. 69). Most of the crew were taken off by helicopters and a lifeboat. The ORION was floated free of the barge on the 27th and towed to Cherbourg. The tanker VENPET under tow Cape Town for Japan put into Algoa Bay on the 12th because of heavy weather damage to the already damaged ship. The British hopper barge W. D. SEAWAY was damaged at St. George's, Bermuda, when sudden 70- to 90-kn winds struck. The 1,599-ton Cypriot tanker ALCHIMIST EMDEN ran aground 18 mi north of Cabo Roca, Portugal, on the 15th in heavy seas. The crew left the vessel. The 5,897-ton Pakistani SUNDERBANS put into Gibralter on the 16th with leaks in shellplating. The vessel had reportedly suffered heavy weather earlier on voyage Montreal to Charleston.

A news report from Havana on the 24th indicated that an unidentified new ship being delivered from the United States to Costa Rica ran aground on coral reefs on the northwest coast of Cuba during severe storms on the 22d. The 20-man crew was taken off by a fishing vessel. There were no injuries. The 20,515-ton Greek ELOCEAN arrived La Pallice, France, on the 28th with heavy weather damage.

The Panamanian cargo vessel PHANTOM was surveyed at Norfolk for alleged heavy weather damage. The American cargo vessel MERRIMAC (15,995 tons) encountered heavy weather off Virginia that damaged dump valves. The German cargo vessel ELISABETH ROTH encountered heavy weather on a voyage from the United States to Saudi Arabia. The container vessel TRANS EUROPA lost containers overboard on a voyage for U.S. East Coast ports.

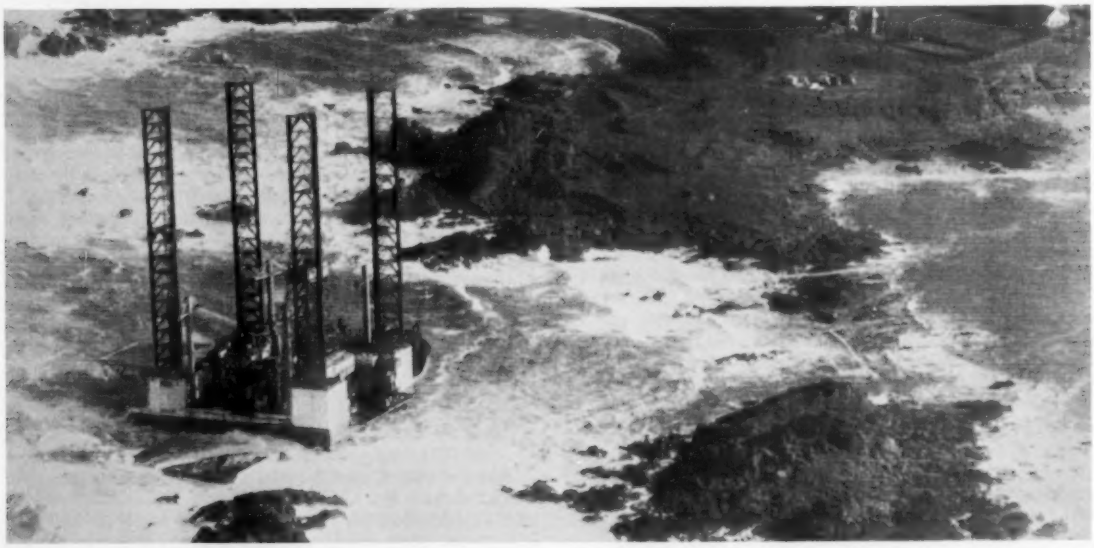


Figure 69.--The 19,000-ton oil rig ORION aboard the barge FEDERAL 400-2 rests on the rocky coast of Guernsey. Wide World Photo.

# Smooth Log, North Pacific Weather

## January and February 1978

SMOOTH LOG, JANUARY 1978--There were more storms across the ocean this month than normal. The location of the primary paths was near normal in pattern and orientation. The primary path of the cyclone centers was from Japan eastward to midocean. There was also a branch from off Japan into the Bering Sea. There were fewer storms than normal that moved into the Gulf of Alaska, but there were more that tracked onto the west coast of North America near Vancouver Island.

The primary mean-pressure feature was the Aleutian Low at 987 mb near 50°N, 176°E. Climatology shows a 999-mb center near 50°N, 170°E. The Pacific High was smaller and weaker than normal at 1019 mb versus 1020 mb, and it was 600 mi southeast of its usual position.

A large 15-mb negative anomaly was also a principal feature. In general the ocean from 30°N to the Bering Strait had negative pressure values.

The upper air flow pattern at 700 mb was quite different from the climatic pattern in that a 2,661-m LOW height center was near 51°N, 176°E, and the normal circulation center was still over the Sea of Okhotsk. There was a trough that paralleled the Asian coast. A large, sharp ridge dominated the North American west coast and Alaska.

There was one tropical cyclone, Nadine, in the western North Pacific early in the month.

Extratropical Cyclones--The first storm of the month originated in the climatological area of cyclogenesis off Japan on the 2d. In any other month it probably would have qualified for the "monster of the month." In a matter of a few hours it was a well-developed storm. A British ship near 34°N, 149°E, about 200 mi southwest of the storm center had 50-kn winds and 20-ft waves. A Japanese ship farther away also had 20-ft waves. At 0000 on the 4th the 976-mb center was near 39°N, 167°E. The VANGUARD, east of the center near 38°N, 177°W, measured 60-kn winds. Two ships reported 54-kn winds. At 0600 the ASIA BOTAN (40°N, 172°E) had 54-kn winds. The PRESIDENT JEFFERSON to the northwest was battered by 20-ft seas and 30-ft swells. Later at 0000 on the 5th, the FEDSTEEL (38°N, 178°W) had 28-ft seas and swells which increased to 34 ft by 0600, and the VAN CONQUEROR (40°N, 172°W) measured 70-kn winds. There were several reports of 15- to 20-ft seas. The Indian cargo vessel CHANDRA GUPTA with 64 crewmembers, 4 wives, and 2 children radioed that it had lost the No.1 hold cover and was taking on water. At 1730 on the 5th the ship was abandoned while 500 mi northeast of Midway Island. The seas were reported as 25 to 30 ft. That night search aircraft spotted the vessel, but the next morning neither the vessel nor any survivors could be found. A lifeboat, jackets, and debris were found. This was one of the worst death tolls in many years. Starting on the 5th at 1800 and continuing for the next 24 hr, there were some very high winds and waves. The STREAM RUDDER reported 39-ft seas and 66-ft swells with 60-kn winds near 37°N, 164°W. At 0000 on the 6th her message read 49-ft seas and 59-ft swells. On the 5th her Remarks section contained the comment, "Severe storm wind gusting to 80 kts," and on the 6th the comment, "Severe storm winds at times gusting 85 kts." Other ships, including the FEDSTEEL SUGAR CARRIER, and ZIM MONTREAL had winds of 50 to 60 kn and seas and/or swells to 40 ft. An American ship that could not be identified near 36°N, 165°W, also reported 51-ft seas. These reports were roughly in the area of 31° to 44°N and 160° to 175°W. At 0000 on the 6th the LOW was 960 mb near 43°N, 162°W. On the 7th the STREAM RUDDER still had 30-ft seas and 48-ft swells, and the FEDSTEEL reported 76-kn winds south of the ship with 50-kn winds. On the 8th there were two reports of swells up to 38 ft southwest of the center. On the 9th the LOW was filling rapidly as it entered the Gulf of Alaska. A ship off the Oregon coast found 60-kn southeasterlies, while another off Dixon Entrance had 25-ft swells from the southeast. The storm dissipated on the 10th.

A short-wave trough was moving around a LOW over the Sea of Okhotsk on the 6th. After the trough crossed Honshu, a LOW formed near 39°N, 148°E. Immediately it was caught in the upper air zonal flow and raced eastward. At 1200 on the 7th there were two reports of winds near 55 kn west of the center. On the 8th the LOW passed 500 mi north of the TACOMA MARU, who was pounding into 26-ft swells. The STREAM RUDDER (35°N, 172°W) was now caught in this storm with 45-kn winds, 10-ft seas, and 30-ft swells. The SEVEN OCEAN about 4° latitude to the north had 25-ft seas and 28-ft swells. The high seas and swells continued into the 10th. At that time a Japanese ship reported 94-kn winds with 30-ft seas and swells about 450 mi southwest of the 976-mb LOW. This may have been a case of using the wrong wind indicator (0 or 1, instead of 3 or 4), and the speed being doubled when it is therefore converted to knots by the computer but is already entered in knots. This continues to be a problem with a few ships. Another ship about 250 mi farther away had 33-ft swells. At this time a secondary LOW formed off the California coast and hit the southern shore with high winds and waves causing flooding and damage to beach homes. A British ship about 300 mi off Los Angeles had southerly 20-ft seas and westerly 33-ft swells. On the 11th the AL DHAFRAH was east of the storm with 66-kn easterly winds. Late in the day two other LOWs absorbed the circulation.

The Sea of Japan was the birthplace of this storm. It moved across Honshu on the 9th and really started to intensify on the 10th. A German ship at 35°N, 149°E, soon found 23-ft waves southwest of the 978-mb LOW. On the 11th the MARITIME ACE (29°N, 149°E) had 31-ft swells and the TACOMA MARU (32°N, 153°E) 28-ft swells. The TEKNOLOG (45°N, 148°E) was blown by

66-kn winds. The PRESIDENT PIERCE (43°N, 180°) was near the occlusion with 50-kn winds, 23-ft seas, and 33-ft swells. At 1800 the LOW had plunged to 950 mb. The VAN ENTERPRISE measured 52-kn winds with 49-ft swells on the 12th near 47°N, 169°E.

On the 12th and 13th a secondary LOW moved from the west to the south side of the storm but dissipated after midday. This increased gradient south of the LOW increased the winds far to the south, and there was a 33-ft swell report near 28°N, 162°E. At this same time the cyclone center became stationary near 53°N, 173°E. The OGDEN TIBER was sailing southeastward near 48°N, 163°E, on the 14th with 26-ft seas and 30-ft swells on her stern. Six hours later the winds were 50 kn and seas and swells 39 ft. The cyclonic circulation and front stretched southward to latitude 20°N. Winds in the 40- to 50-kn category and seas and swells in the 15- to 20-ft range continued until late on the 16th, when another cyclone took over.

This storm was the combination of two storms which joined forces some distance off the California coast. A series of LOWs had formed and dissipated on the edge of a stationary cyclone over the Gulf of Alaska. This came into being on the 11th near 32°N, 150°W. Since there was already a cyclonic circulation over the area, it did not take long for high seas and swells to develop. The TAIWAN PHOENIX fought 30-ft seas and swells near 29°N, 154°W. The CALIFORNIAN was a few miles to the east with 60-kn winds and 23-ft swells. On the 12th a ship northwest of the 978-mb center had 28-ft confused seas.

Late on the 12th another LOW formed to the northwest on the old occluded front of another LOW. The EXPORT BANNER was 15° of longitude west of San Francisco on the 13th with 36-ft swell waves. On the 14th the PESTOVO, southwest of the two centers near 39°N, 151°W, pounded into 45-kn gales and 33-ft seas. At 1200 the two centers combined. Two ships in the vicinity of 40°N, 145°W, had 60-kn winds and swells as high as 39 ft. On the 15th the ANCO EXPRESS was stationary near 39°N, 144°W, probably waiting for the 33-ft swells to subside. On the 15th the LOW was absorbed by another as it raced into the area from the west. This new LOW and another which followed brought 50- to 55-kn winds and up to 20-ft seas to the area before a large cyclone centered over the Aleutians became the dominant circulation.

A cyclone developed in an area of flat gradient west of the Sea of Japan on the 14th. As usual, it increased in size and intensity as it crossed the Kurile Islands over the warmer waters of the Pacific. The first storm wind report was at 0600 on the 16th. On the 17th the 956-mb LOW was near 46°N, 169°E, and the PRESIDENT POLK was being pounded on the starboard side by 50-kn winds and 28-ft seas. A ship 250 mi south of the center had 33-ft seas, and another ship very near the center with 962-mb pressure had 23-ft swells. The HAKUSAN MARU registered a pressure of 960.5 mb 12 hr later. The VAN WARRIOR (46°N, 170°E) had 70-kn winds with no seas reported. One hundred miles closer to the LOW another ship had 65 kn.

The LOW was 963 mb on the 19th centered near Unimak Island. The GEORGE WALTON was about 1,400 mi southeast of the storm's center with 70-kn winds. The MONTEREY was 20° of longitude to the east also with 70-kn winds. The swell waves of 20- to 30-ft were in a band averaging 1,200 mi from the center and from the southwest to the southeast. On the 20th the PRESIDENT JEFFERSON was 800 mi south of the center with 20-ft seas and 36-ft swells. Later the center turned northwestward and filled rapidly as another storm approached from the southwest.

This storm was one of seven that originated off the Japanese coast. Within a few hours it was producing storm-force winds and waves to 30 ft on the 21st. The Singapore-flag freighter WATEL (2,992 tons) sank off Kyushu. Ten seamen were killed, 3 were missing, and 12 were rescued by Maritime Self Defense Force ships. At 1200 on the 22d the LOW was 962 mb near 43°N, 150°E. In the area bounded by the center, 30°N, 145°E, and 155°E, there were many wind reports of 50 kn or greater and seas and swells up to 30 ft. The 0600 and 1200 collective had 23 reports. The PINK SKY (40°N, 146°E) had 65-kn winds and 35-ft seas and swells. The SHUNWIND took an 0900 observation and measured 50-kn winds, 26-ft seas, and 43-ft swells. Severe weather reports continued into the 23d, with the GOLDEN BEAR near 42°N, 150°E, transmitting 50-kn winds, 33-ft seas, and 49-ft swells. On the 24th the wind intensity decreased, but the high swells continued. The LOW was now 964 mb. On the 25th the storm crossed into the Bering Sea and quickly perished.

The Yellow Sea contributed this storm. On the 24th it was south of Tokyo and rapidly expanding. On the 25th there were winds over 50 kn and seas and swells up to 20 ft. A Japanese ship near 35°N, 154°E, had quartering 64-kn winds. The HONG KONG PHOENIX (37°N, 164°E) and the ILLINOIS (45°N, 156°E) had 50- and 55-kn winds and 30- and 33-ft seas and swells, respectively, on the 26th. Winds and waves of 50 to 60 kn and up to 33 ft continued through the 27th. At 0000 of that day the 964-mb storm was near 47°N, 174°E. On the 28th the storm was moving northwestward and weakening rapidly.

A shallow LOW could be traced from the Mongolian Desert to the Yellow Sea. It was over the Yellow Sea where intense cyclogenesis and frontogenesis took place on the 26th. Two ships had 50- to 60-kn winds off Tokyo over the Japan Trench early on the 27th. At 0600 the ILLINOIS was north of the 982-mb center with 50-kn northeasterly winds and 30-ft swell waves. Winds of 50 to 60 kn with waves to 33 ft were found on the 28th. The LOW was intense, but its circulation was not spreading over as large an area as the previous LOW's. At 0000 on the 29th the 962-mb storm was centered near 42°N, 179°E. As with other storms in this series, the LOW turned northwestward on the 31st and deteriorated into a trough by February 1.

Back to frontal waves. This wave appeared on the 0000 chart of the 29th south of Tokyo. It was the fourth and westernmost of a series of frontal-wave

cyclones that stretched across the Pacific. On the 30th the EDEN MARU was south of the 976-mb center with 60-kn winds. Another ship not far away was sailing into 23-ft seas and swells. The storm passed about 120 mi north of the LONG BEACH at 1800, and at 0000 on the 31st (LONG BEACH - 36°N, 178°E; storm - 38°N, 178°W) she had 60-kn winds. The wave report wast 32445. This could have been either a sea or swell report as the wind was from 320°, the period could have been either 14 or 24 S and the height still works out at 74 ft. There were other wave reports of 20 to 30 ft in the area so that height seems far out, but odd things happen over the ocean and there are often powerful local forces at work. A report on February 1 by the SEA LAND MCLEAN (38°N, 171°W) in the same general relationship to the center of 52-ft seas and swells with 60-kn winds gives some credence to the 74 ft. On the 2d the storm curved northward and became stationary near 46°N, 160°E, where it was absorbed by another storm.

Tropical Cyclones--Nadine came together on the 8th about 150 mi south of Eniwetok. As a tropical storm she passed west of the atoll on the 10th. Continuing northward, Nadine generated 40- to 45-kn winds close to her center. On the 11th she swang to the east-northeast. Winds climbed to 55 kn the following day as Nadine turned northeastward and crossed the 170th meridian near the 20th parallel. By the 13th she was turning extratropical.

Casualties--The storm that produced the weather damage for some of these casualties may be described in the text, but the information available was not sufficient to determine the storm involved.

The 49,808-ton Greek tanker OCEAN VICTORY had heavy weather damage on the 5-7th including catwalks ladders, gangways, derrick, boom, piping, and guardrails. The British tanker(15,425 tons)ANCO EMPRESS encountered heavy weather 12th-17th. The 44,742-ton Greek bulkcarrier AGIOS NICOLAOS V from Vancouver to Durban reported on the 12th with heavy weather damage. On the same day the 8,242-ton Panamanian cargo vessel ELENA was at Kobe with damage to a crane. On the 13th, 11,192-ton Indian RATNAMANORAMA arrived Madras Roads with damage. Another Indian vessel, the 22,593-ton MARATHA PROVIDENCE, reported a hole in number 5 hold and required assistance because of heavy weather on the 24th. On the 16th the Greek bulkcarrier EVELPIDIS ERA (9,706 tons) sank after hold No. 3 flooded in heavy weather near 41.6°N, 143.8°E. The crew was rescued. The Singapore WAT I (2,993 tons) sank near 31.9°N, 128.9°E, on the 21st under similar circumstances when a hatch cover broke during heavy weather. Ten of the crew of 25 were rescued with 12 dead and 3 missing.

The 13,037-ton Liberian cargo vessel SILVER PAGODA arrived Pusan on the 25th with a lost hold cover during heavy weather. The Liberian-registered JAPAN VENTURE (9,630 tons) at Miyako on the 26th with heavy weather damage.

SMOOTH LOG, FEBRUARY 1978--The cyclone tracks generally followed the overall climatological pattern. The favorite area of cyclogenesis off the coast of Japan was farther east than normal, and the average tracks stayed farther south before turning toward Alaska after midocean. The tracks across the Bering Sea were generally storms traveling east to west, rather than the usual vice versa. Although the storms severely affected the U.S. West Coast, only two significant centers crossed the coast.

The mean pressure pattern consisted mainly of one large Low. Its 989-mb center was near 50°N, 160°W. This compares with a 999-mb climatological center near 50°N, 180°. The Pacific High at 1019 mb near 28°N, 128°W, compared favorably with climatology. The 1029-mb High over central Canada was a blocking influence on storms moving across the western mountains intact.

The 20° longitudinal displacement of the Aleutian Low produced a minus 17-mb anomaly near 49°N, 158°W. Basically, there were negative anomalies over the ocean north of 28°N. The higher pressure over Canada resulted in a positive 9-mb anomaly center north of Lake Winnipeg.

The upper air Low at 700 mb was more oval than usual with two centers about 200 ft lower than normal. The western center was not far from the climatic center near the Kamchatka Peninsula. The eastern and primary center was near 50°N, 180°. This produced a more zonal (west to east) flow over the midocean and a much sharper ridge over the Rocky Mountains. This resulted in more northerly flow off the Pacific Coast from Oregon northward.

There were no tropical cyclones this month.

Extratropical Cyclones--The first cyclone of the month came into being about 500 mi east of Tokyo on the 1st. The ARCO FAIRBANKS was headed westward into 50-kn winds near 30°N, 154°E. By 0000 on the 3d the 966-mb center was near 46°N, 179°W. The cold northerly flow west of the LOW brought heavy snow to the area of Japan facing the Sea of Japan. At Tokyo the mercury dropped to -2°C--the lowest for the winter at that time. The heavy snow caused the cancellation of more than 100 trains plus many delays. The ZEALAND VENTURE was 350 mi to the southwest with 50-kn westerlies and 13-ft seas. The FED-STEEL was near Unimak Island with 55-kn easterlies and 13-ft seas. At 0600 they had increased to 66 kn from the southeast. At 0000 on the 4th the JAPAN ACACIA was moving eastward with the storm and had 55-kn winds and 23-ft waves in the southwest quadrant. A ship not far from the occlusion was pounding into 21-ft waves.

On the 5th the LOW split into two centers as a fast-moving storm moved in from the west. At 1200 the PHILADELPHIA near 55°N, 140°W, had 20-ft seas. Between 1200 on the 5th and 0000 on the 6th the synoptic situation changed radically. The two centers disappeared and a new one popped up south of Anchorage with a pressure of 946 mb. The PHILADELPHIA now near 55°N, 136°W, was sailing into 23-ft seas and 33-ft swells. The LOW coming in from the west was racing eastward. The DIAHONSHU MARU found 58-kn winds off San Francisco, and a ship far south near 35°N was sailing with 29-ft swells. The SANICO STEEL, only a few miles from Unimak Island, found 50-kn winds and 30-ft seas. The SAN-

SINENA 2 near 43°N, 127°W, battled 50-kn southwesterlies and 25-ft waves.

On the 8th the new LOW at 960 mb was over the Gulf of Alaska and had become the primary storm. The GREAT LAND and ASIA BOTAN east and west of the center, respectively, fought winds over 60 kn. The reported waves were from 15 to 33 ft. The ARCO PRUDHOE BAY (52°N, 133°W) was tossed by 65-kn winds and 23-ft waves on the 9th. Another cyclone had been racing eastward along approximately 40°N and turned northward as it reached the coast to replace this LOW on the 10th. Winds as high as 70 kn were found by the GLADIOLUS.

During this period this series of storms dumped near record heavy snows and high winds on the south coast of Alaska. Anchorage recorded 20.8 in and Valdez 63.4 in. Schools were closed in Anchorage for the first time since the 1964 earthquake. This was the heaviest snowstorm in Anchorage since the all-time record of 35.7 in during December 26-30, 1955. Storm-force winds and heavy freezing spray occurred at Kodiak Island, Alaska Peninsula, and Lower Cook Inlet. At the Barren Islands north of Kodiak there were northwesterly gusts estimated at 120 kn. Now it's known why they are called barren. On the 11th this cyclone dissipated and was replaced by another not so severe.

For about a week frontal systems had been crossing the California coast at 24 to 36 hr intervals bringing rain and high winds. The American cruise ship MONTEREY broke her mooring lines in San Francisco Bay on the 6th when winds gusted to 56 kn. On the 9th a LOW was moving northward off the Washington coast and the attendant front moved over the coast. On the 1200 analysis a frontal wave had formed near 32°N, 132°W. It deepened and consolidated as it moved eastward bringing heavy rain to southern California.

At 1200 on the 10th the 990-mb storm was centered over central California and high winds were blowing along the southern coast, bringing high seas and surf to the area. The ZIM HAIFA, an Israeli container vessel at Long Beach broke her stern lines in near 80-kn gusts and struck the opposite dock area. The harbor was closed from 0313 to 1202 local time. Farther south at San Diego the dredger TEXAS sank on the mudflat in the South Bay. The dredger was refloated on the 16th. Flash flooding and landslides resulted from the heavy rain. On the 11th the LOW had moved inland over the Nevada-Idaho border and the storm was no longer a danger to the coastal areas.

This cyclone formed near 44°N, 170°W, on the 10th in a trough following a cold front. On the 11th a Japanese ship was sailing with 23-ft swells southwest of the center, and a SHIP had 55-kn winds and 23-ft seas southeast of the center. The PRESIDENT ROOSEVELT had 50-kn winds and 30-ft seas near 37°N, 150°W, and a SHIP nearby reported 30-ft swells. At 0000 on the 12th the LOW was 972 mb near 49°N, 139°W. A ship with the call sign D7OM was at 39.5°N, 144.9°W, and reported 52-kn winds from 290° with 39-ft seas and 56-ft swells from 300°. The KINYO MARU measured 51-kn winds, 15-ft seas, and 41-ft swells near 37°N, 141°W, at 0300. The IRISH STAR had 36-ft swell waves. A secondary trough had passed over the ship a few hours earlier, and a closed circulation was analyzed in the trough on the 1200 chart. On the 0000 chart of the 13th the data no longer supported the existence of the original LOW.

During the first 48 hr this storm raced eastward across the Pacific at an average speed greater than 50 kn. It was first analyzed over the Yellow Sea on the 9th. As the storm sped past Tokyo on the 10th, it treated the FEDSTEEL to 60-kn northerly winds off the Japan coast. The CEDARBANK was due east near longitude 152°E with 39-ft swells. By 0000 on the 11th, the storm was 984 mb with its circulation expanding. Another LOW was centered east of the Kamchatka Peninsula, and together they were feeding very frigid air southward over the warmer ocean currents. The winds were generally gale strength with 15- to 25-ft waves, but the SPRUCE near 47°N, 167°W, measured 60-kn winds with 17-ft seas and swells.

The storm slowed considerably on the 12th as it turned northeastward. Two ships reported 30-ft waves in the southern quadrant. On the 14th the storm was moving northwestward and crossed the Alaska Peninsula. A secondary LOW had formed in the southeast quadrant and moved into the Gulf of Alaska. Winds of 50 kn and seas 15 to 25 ft were being reported. On the 15th the original LOW died over the Bering Sea as did the new storm over the Gulf of Alaska. Winds of 50 kn and waves to 30 ft were still being reported to the south of the latter LOW.

This was a series of LOWs associated with upper air, short-wave troughs moving eastward aouund the primary center of the long wave trough and LOW. They formed southeast of Japan and followed at about 18-hr intervals. On the 14th the PINK SKY (35°N, 178°W) was near one of the centers with 40-kn winds, 26-ft seas, and 30-ft swells. The VAN WARRIOR was east of a following LOW (42°N, 178°E) at 1800 with 65-kn southerly winds. Six hours later her winds were 70 kn. Other ships were reporting waves of 15 to 25 ft. On the 16th a British ship had 50-kn winds and 20-ft waves south of yet another LOW. On the 18th this one was west of Seattle at 960 mb. The TAIWAN PHOENIX (50°N, 145°W) measured 45-kn winds with 33-ft waves. The ARCO JUNEAU measured 63-kn winds and 26-ft seas near 58°N, 146°W. Buoy 46001 measured 41-kn winds and 17-ft waves. As each storm moved into the Gulf of Alaska or Bering Sea, it rapidly dissipated.

The ocean was cut up by multiple LOWs on the 18th and 19th. There were still many centers on the 20th, but this one was destined for greater things. At 0000 on the 20th the 980-mb center was near 36°N, 172°W. On the 21st ships were reporting 20- to 25-ft waves and gale-force winds south and east of the storm. At 1800 the PRESIDENT TRUMAN (49°N, 147°W) had 33-ft swells. The storm had a pressure of 960 mb at 0000 on the 22d. The SEA-LAND EXCHANGE near 48°N, 150°W, was sailing eastward with 33-ft swells. The NEWARK, PORTLAND, and PRESIDENT TRUMAN were in the Gulf of Alaska with winds over 50 kn and waves as high as 33 ft. The pressure pattern had become better organized. Another ship 750 mi southeast of this LOW and 700 mi east of another LOW had

33-ft swells striking her port quarter. The second LOW was supporting 50-kn winds and 25-ft waves.

At 1200 a ship near 56°N, 146°W, had 28-ft waves and the NEWARK reported 50-kn winds and 20-ft swells. At 1800 the PHILADELPHIA near 58°N, 149°W, was running with 50-kn southerlies supporting 36-ft seas and 41-ft swells. The storm was now tracking westward across the Alaska Peninsula into the Bering Sea where it dissipated on the 25th.

A Kuroshio Current storm. It developed off Tokyo on the 21st southwest of another LOW. Within 12 hr it was the primary circulation at 988 mb. At 1200 on the 22d the storm was 966 mb near 46°N, 172°E. A trough extending southwestward produced 50-kn winds with a thunderstorm. A ship with the call letters ZCJN was pounding into 50-kn westerly winds with 30-ft seas and 34-ft swells. The GREEN ECHO at 43°N, 171°E, measured 50-kn winds with 200-yd visibility. The seas were 17 ft. The storm continued to move northeastward with the PRESIDENT POLK encountering 26-ft swells about 1,000 mi south of the center. On the 25th the storm was over the Alaska Peninsula, and the buoy 46003 recorded 23-ft waves. By the 26th the storm had disappeared.

This storm formed slightly south and east of where the previous storm generated. There was evidence of cold frontogenesis early on the 24th. Two ships behind the southwest-northeast-oriented trough had 25-ft swells. On the 25th the front was well established, and the SHIN HONSHU MARU about 300 mi south of the 972-mb center was traveling eastward with 50-kn winds and 30-ft swell waves. Ships east and southwest of the LOW fought 23-ft swells. At 1200 the SHUNWIND (42°N, 177°W) had 55-kn westerly winds with 20-ft seas and 33-ft swells. The storm was turning northward on the 26th as the LOW dropped to 960 mb near 48°N, 172°W. The SEALIFT PACIFIC was cruising eastward, when she radioed a special 0200 observation of 60-kn winds and 25-ft seas and swells near 47°N, 172°W.

As the storm moved over the cold Bering Sea, it started the deterioration process which ended on the 28th.

As the previous storm moved eastward it left a large area of flat pressure gradient in the vicinity of the Japanese Islands, as the cold high pressure over Asia remained stationary. As usual in nature and meteorology, this situation does not exist for long, and a cyclonic circulation was found on the analysis of the 25th.

By 0000 on the 27th the LOW was 980 mb near 39°N, 179°W. At that time two ships radioed 50-kn winds, with one measuring 33-ft swells. Only 24 hr later the central pressure had plunged to 959 mb. The storm had caught up to the SEALIFT PACIFIC, and she had 70-kn winds with 41-ft seas near 40°N, 166°W. There were six other reports of 60 kn or more near the storm with several containing waves over 25 ft. There were few reports at 1200, but the SEA-LAND COMMERCE north of the center found 50 kn and 30 ft. At 0000 on March 1 a Japanese ship near 49°N, 178°W, was about 150 mi northwest of the 966-mb center with 43-ft swell waves. The SEA-LAND COMMERCE was headed toward Seattle with 30-ft waves. By the 2d another center had become primary.

This storm barely made the month. It developed over the Sea of Japan late on the 27th. By 0000 on March 1 it was 970 mb slightly east of Hokkaido. Strong winds raged along the Pacific coast of Honshu from the 28th to the 1st, causing heavy weather damage to houses and disrupting air and rail services. There were 2 deaths and 50 injuries attributed to the high winds. Winds up to 78 kn were recorded in Tokyo. The 12,947-ton Liberian freighter SEVENSEAS with a cargo of logs ran aground in high winds off Akita in northern Honshu. The LAURENTIAN FOREST was headed toward Tokyo and found 60-kn winds with 20-ft waves at the cold front. At 1200 a ship that appeared to be the TRIUMPH along the occluded front near 41°N, 158°E, had 45-kn winds, 13-ft seas, and giant 46-ft swells. There were many reports of winds greater than 50 kn and waves up to 30 ft. Late on the 2d a SHIP near 37°N, 155°E, claimed 45-ft swell waves. At that time a new LOW formed at the point of occlusion and raced eastward. The tighter gradient was still with the original LOW and the ZCJN at 36.4°N, 154.1°E, had 60-kn westerly winds with 33-ft seas and 46-ft swells. Swells of 30 ft were being found as far as 800 mi south of the LOW.

The storm was now a double-centered LOW, both moving eastward. The circulation was nearly circular and covered a large part of the ocean. The winds were generally in the gale category with waves up to 25 ft. On the 4th the original LOW was replaced by another.

Casualties--The 41,750-ton EASTERN MOBILITY, Los Angeles for Singapore, arrived on the 3d with heavy weather damage. The 14,000-ton American cargo vessel MAINE arrived Seattle on the 6th with 17 yachts lost overboard during heavy weather. The 3,740-ton barge POWELL CARRIER sustained hull damage off Point Sur during heavy weather on the 11th. Approximately 75 percent of the cargo of lumber was washed overboard. The Greek SEASPEED AMERICA encountered heavy weather after leaving Yokohama on the 11th and 55 containers were damaged. The Indian cargo vessel CHENNAI OOKKAM (24,365 tons) encountered heavy weather between Japan and Vancouver. Another Indian vessel, the MARATHA PROVIDENCE (39,480 tons) reported need of assistance due to weather damage arrived Yokohama on the 14th. The 4,967-ton ZEPHUNTER left Tacoma on the 11th and encountered force 8 winds west of Cape Flattery on the 12th, which broke lashings and allowed cargo to move. The ship returned to Tacoma.

The 11,434-ton WORLD PRIDE was due Osaka on the 20th with heavy weather damage. The 12,943-ton tanker ATHENIAN HORIZON reported heavy weather damage at Shanghai on the 23d. The 7,027-ton MARGUERITE VENTURE encountered heavy weather between Papeet and Apia on the 24th. Containers broke loose and punctured tanks.

## Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic

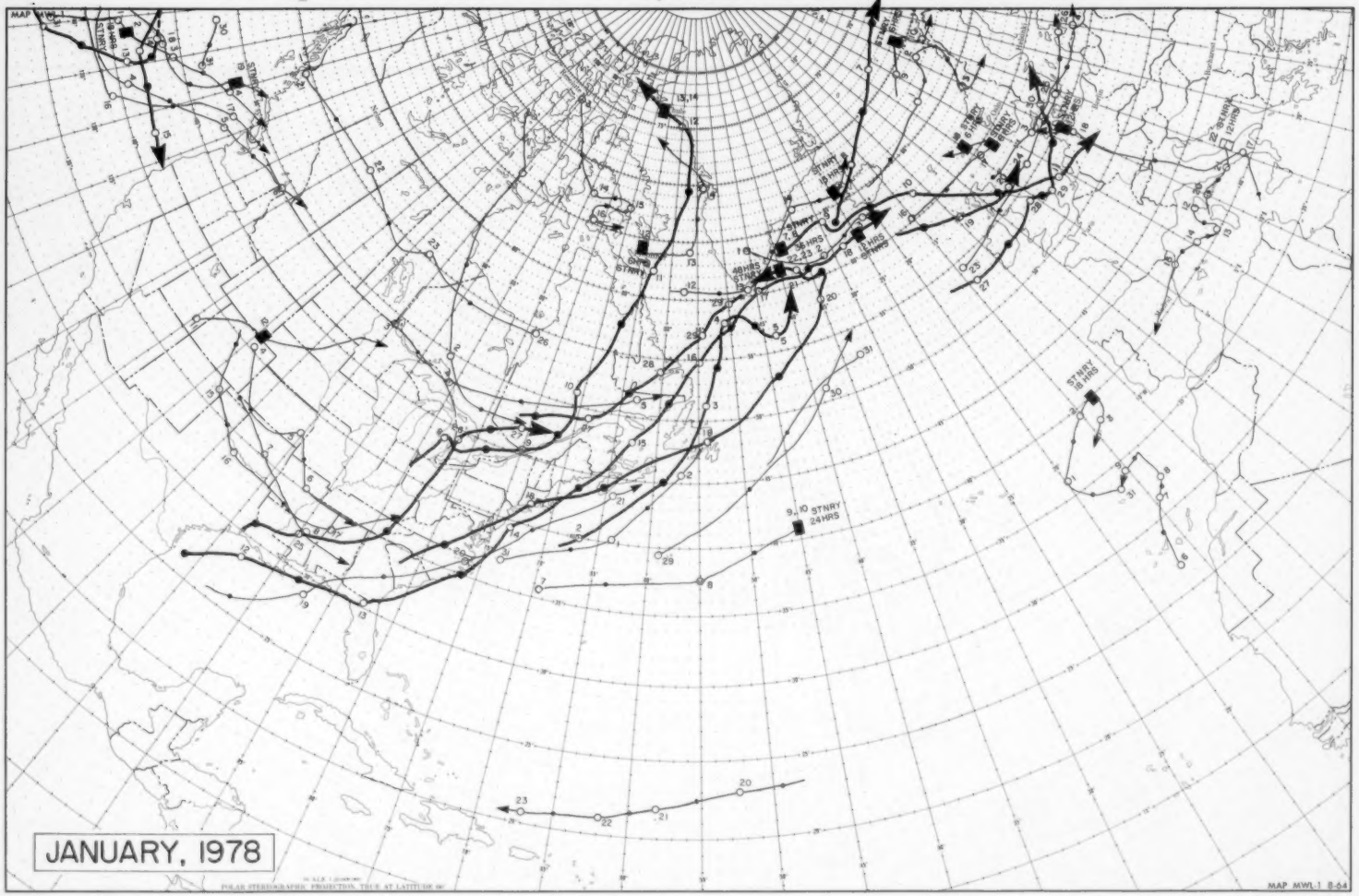



Figure 70.--Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

## Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic

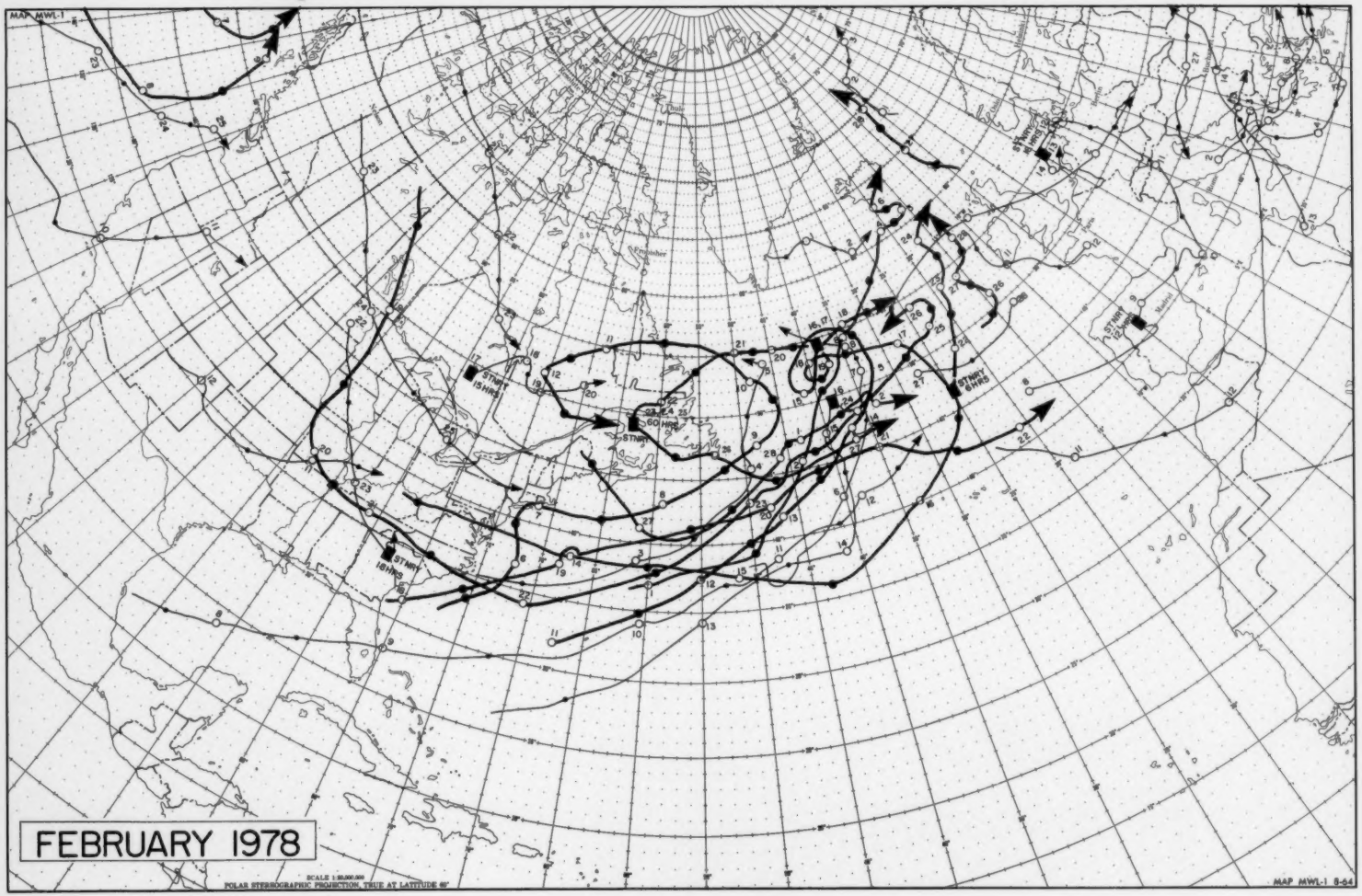



Figure 71.--Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

# Principal Tracks of Centers of Cyclones at Sea Level, North Pacific

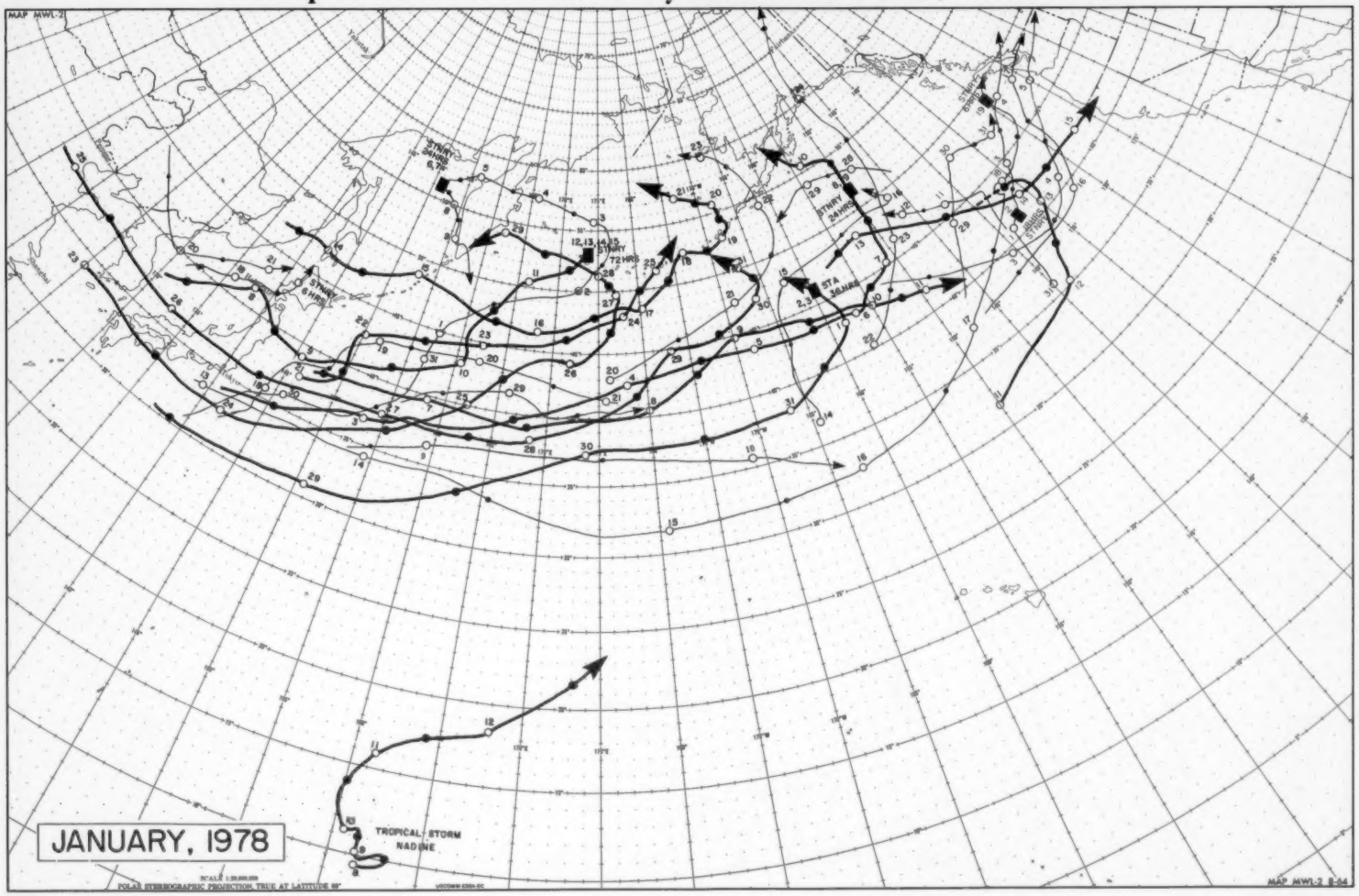



Figure 72.--Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

## Principal Tracks of Centers of Cyclones at Sea Level, North Pacific

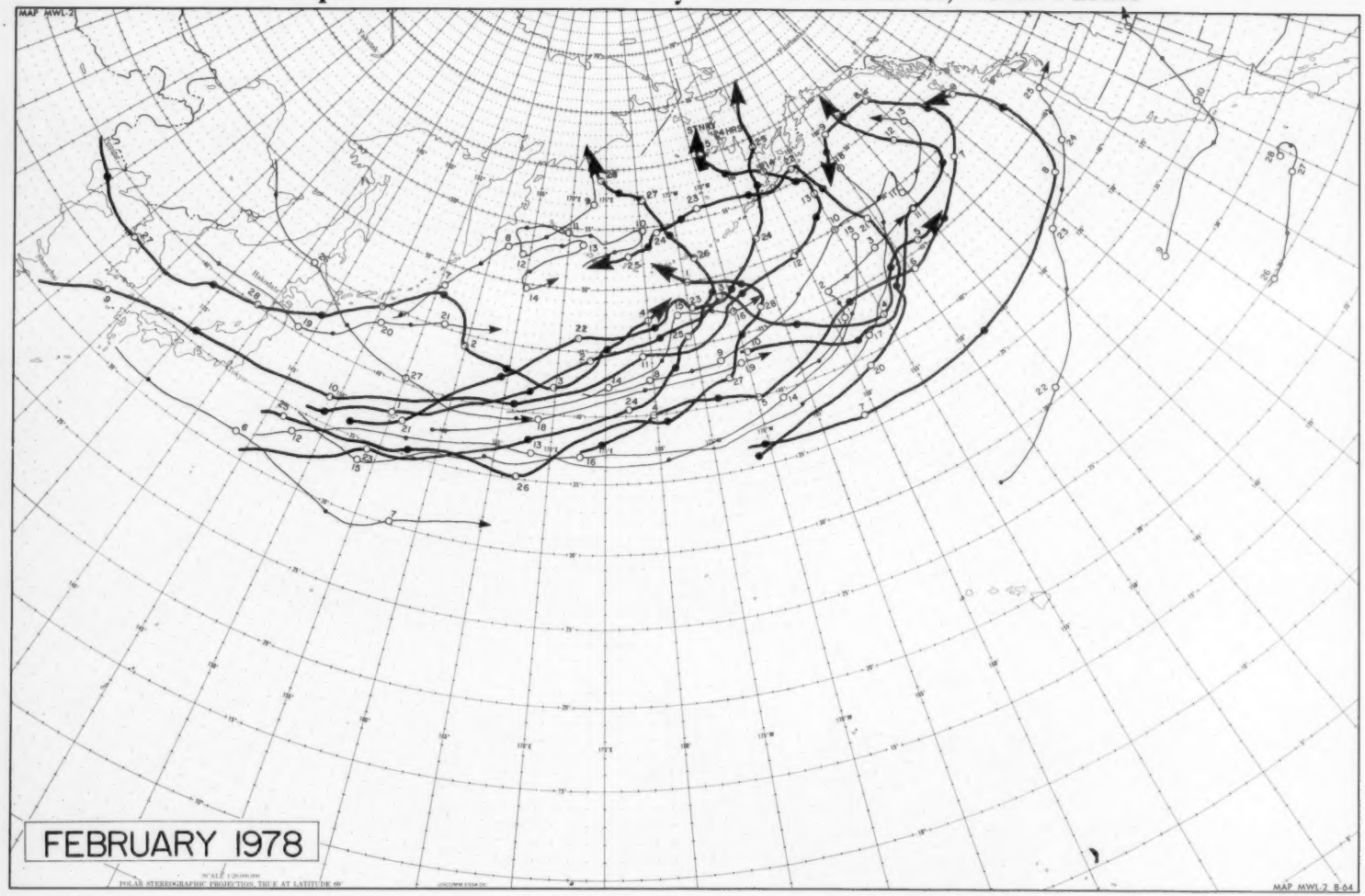



Figure 73. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

# Table 7

# U.S. Ocean Buoy Climatological Data

## January and February 1978

JANUARY D A T A S U M M A R Y 41002
AVERAGE LATITUDE 32.3N AVERAGE LONGITUDE 075.3W

| MEANS AND EXTREMES | MIN | (DA HR) | MEAN | MAX | (DA HR) | NO. OF OBS | DAYS WITH DATA |
|---|---|---|---|---|---|---|---|
| AIR TEMP (DEG C) | 06.2 | (28 15) | 15.2 | 22.8 | (26 09) | 248 | 31 |
| SEA TEMP (DEG C) | 20.8 | (07 15) | 22.5 | 24.3 | (12 15) | 248 | 31 |
| AIR-SEA TEMP (DEG C) | -15.8 | (26 18) | -07.1 | 00.9 | (09 08) | 248 | 31 |
| PRESSURE (MBAR) | 1002.1 | (26 09) | 1018.9 | 1033.3 | (04 15) | 248 | 31 |

WIND - % FREQUENCIES, MEANS AND EXTREMES

| DIR | SPEED (KNOTS) <4 | 4-10 | 11-21 | 22-33 | 34-47 | >47 | TOTAL % | MEAN SPEED (KNOTS) |
|---|---|---|---|---|---|---|---|---|
| N | .0 | 3.6 | 3.2 | | | | 7.7 | 10.1 |
| NE | .4 | 3.6 | 4.4 | | | | 8.5 | 10.7 |
| E | .8 | 3.2 | 2.0 | | | | 6.0 | 9.0 |
| SE | | 2.4 | 2.8 | 1.2 | | | 6.5 | 15.3 |
| S | | 1.6 | 6.9 | 7.7 | 3.2 | | 19.4 | 24.4 |
| SW | | | .4 | .8 | 2.4 | | 3.6 | 35.6 |
| W | | | 5.6 | 18.5 | 3.2 | | 27.4 | 25.1 |
| NW | | 1.2 | 16.5 | 3.2 | | | 21.0 | 17.0 |
| CALM | 1.2 | | | | | | 1.2 | |
| TOTAL % | 2.0 | 15.7 | 41.8 | 31.5 | 8.8 | | 100.0 | 19.5 |

NO. OF WAVE OBS: 248
MAX WIND SPEED: 46 KNOTS
DIRECTION: 270 DEG
DAY: 08
HOUR: 15

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 248

| HEIGHT (M) | <1 | 1-1.5 | 2-2.5 | 3-3.5 | 4-5.5 | 6-7.5 | 8-9.5 | >9.5 | MEAN | MAX (DA HR) |
|---|---|---|---|---|---|---|---|---|---|---|
| % FREQUENCY | 4.0 | 42.3 | 28.6 | 13.7 | 10.5 | .8 | | | 2.1M | 6.5M (08 18) |

FEBRUARY D A T A S U M M A R Y 41002
AVERAGE LATITUDE 32.3N AVERAGE LONGITUDE 075.3W

| MEANS AND EXTREMES | MIN | (DA HR) | MEAN | MAX | (DA HR) | NO. OF OBS | DAYS WITH DATA |
|---|---|---|---|---|---|---|---|
| AIR TEMP (DEG C) | 05.1 | (23 03) | 13.6 | 25.1 | (18 00) | 224 | 28 |
| SEA TEMP (DEG C) | 19.8 | (17 08) | 21.7 | 23.8 | (03 18) | 224 | 28 |
| AIR-SEA TEMP (DEG C) | -16.0 | (07 12) | -08.1 | -00.4 | (17 06) | 224 | 28 |
| PRESSURE (MBAR) | 1005.4 | (18 09) | 1018.9 | 1029.5 | (02 00) | 224 | 28 |

WIND - % FREQUENCIES, MEANS AND EXTREMES

| DIR | SPEED (KNOTS) <4 | 4-10 | 11-21 | 22-33 | 34-47 | >47 | TOTAL % | MEAN SPEED (KNOTS) |
|---|---|---|---|---|---|---|---|---|
| N | | | 5.8 | 10.7 | 8.5 | | 25.0 | 18.8 |
| NE | | | 2.2 | 7.1 | 1.8 | | 11.2 | 14.9 |
| E | | | 1.8 | 5.4 | | | 7.1 | 14.4 |
| SE | | | | 2.2 | | | 2.2 | 16.0 |
| S | | | .4 | .4 | 4.0 | | 4.9 | 23.5 |
| SW | | .4 | | 2.7 | 1.8 | | 4.9 | 19.0 |
| W | | | .9 | 11.2 | 8.9 | 1.8 | 22.8 | 22.4 |
| NW | | .4 | .9 | 10.3 | 6.5 | 1.8 | 21.9 | 21.5 |
| CALM | 1.3 | | | | | | 1.3 | |
| TOTAL % | .9 | 12.9 | 48.6 | 33.5 | 5.6 | | 100.0 | 16.2 |

NO. OF WAVE OBS: 224
MAX WIND SPEED: 40 KNOTS
DIRECTION: 280 DEG
DAY: 22
HOUR: 15

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 224

| HEIGHT (M) | <1 | 1-1.5 | 2-2.5 | 3-3.5 | 4-5.5 | 6-7.5 | 8-9.5 | >9.5 | MEAN | MAX (DA HR) |
|---|---|---|---|---|---|---|---|---|---|---|
| % FREQUENCY | | 41.5 | 34.8 | 13.8 | 5.8 | | | | 2.1M | 4.5M (23 06) |

JANUARY D A T A S U M M A R Y 42002
AVERAGE LATITUDE 28.0N AVERAGE LONGITUDE 083.5W

| MEANS AND EXTREMES | MIN | (DA HR) | MEAN | MAX | (DA HR) | NO. OF OBS | DAYS WITH DATA |
|---|---|---|---|---|---|---|---|
| AIR TEMP (DEG C) | 14.3 | (28 03) | 19.0 | 22.1 | (24 15) | 81 | 11 |
| SEA TEMP (DEG C) | 20.3 | (31 15) | 21.3 | 21.8 | (29 06) | 81 | 11 |
| AIR-SEA TEMP (DEG C) | -08.8 | (26 03) | -02.3 | 00.7 | (31 19) | 81 | 11 |
| PRESSURE (MBAR) | 1001.8 | (26 09) | 1018.9 | 1028.4 | (28 06) | 81 | 11 |

WIND - % FREQUENCIES, MEANS AND EXTREMES

| DIR | SPEED (KNOTS) <4 | 4-10 | 11-21 | 22-33 | 34-47 | >47 | TOTAL % | MEAN SPEED (KNOTS) |
|---|---|---|---|---|---|---|---|---|
| N | | | 2.5 | | | | 2.5 | 14.0 |
| NE | | 1.2 | 3.7 | | | | 5.0 | 9.0 |
| E | | 7.4 | 18.5 | 3.9 | | | 29.4 | 14.1 |
| SE | | 3.7 | 30.9 | 1.2 | | | 35.8 | 16.3 |
| S | | 3.7 | 17.3 | | | | 21.0 | 12.3 |
| SW | | | | | | | | |
| W | | | 1.2 | 1.2 | | | 2.5 | 24.1 |
| NW | | | 2.5 | 3.7 | | | 6.2 | 24.8 |
| CALM | 1.2 | | | | | | 1.2 | |
| TOTAL % | | 16.0 | 76.5 | 8.8 | | | 100.0 | 19.2 |

NO. OF OBS: 81
MAX WIND SPEED: 32 KNOTS
DIRECTION: 300 DEG
DAY: 25
HOUR: 21

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 81

| HEIGHT (M) | <1 | 1-1.5 | 2-2.5 | 3-3.5 | 4-5.5 | 6-7.5 | 8-9.5 | >9.5 | MEAN | MAX (DA HR) |
|---|---|---|---|---|---|---|---|---|---|---|
| % FREQUENCY | 4.9 | 51.9 | 34.6 | 2.5 | 6.2 | | | | 1.8M | 5.0M (26 03) |

FEBRUARY D A T A S U M M A R Y 42002
AVERAGE LATITUDE 28.0N AVERAGE LONGITUDE 083.5W

| MEANS AND EXTREMES | MIN | (DA HR) | MEAN | MAX | (DA HR) | NO. OF OBS | DAYS WITH DATA |
|---|---|---|---|---|---|---|---|
| AIR TEMP (DEG C) | 11.1 | (21 21) | 17.3 | 21.7 | (28 21) | 223 | 28 |
| SEA TEMP (DEG C) | 18.3 | (24 00) | 20.2 | 21.7 | (28 21) | 223 | 28 |
| AIR-SEA TEMP (DEG C) | -08.7 | (22 00) | -03.0 | 01.4 | (12 21) | 223 | 28 |
| PRESSURE (MBAR) | 1003.8 | (12 21) | 1018.0 | 1032.2 | (22 15) | 223 | 28 |

WIND - % FREQUENCIES, MEANS AND EXTREMES

| DIR | SPEED (KNOTS) <4 | 4-10 | 11-21 | 22-33 | 34-47 | >47 | TOTAL % | MEAN SPEED (KNOTS) |
|---|---|---|---|---|---|---|---|---|
| N | | 5.4 | 17.0 | | | | 22.4 | 13.2 |
| NE | 1.3 | 5.4 | 14.8 | 1.3 | | | 22.8 | 15.1 |
| E | | 5.8 | 8.1 | | | | 13.9 | 11.0 |
| SE | | 5.4 | 8.5 | 1.8 | | | 19.7 | 13.7 |
| S | 1.8 | 5.8 | 5.4 | | | | 13.0 | 8.8 |
| SW | | .4 | 1.8 | | | | 2.2 | 14.8 |
| W | | .4 | 1.3 | | | | 1.8 | 16.5 |
| NW | | .4 | 3.1 | 4.0 | .4 | | 8.1 | 12.1 |
| CALM | 1.3 | | | | | | 1.3 | |
| TOTAL % | 4.5 | 34.1 | 57.8 | 5.6 | | | 100.0 | 12.0 |

NO. OF OBS: 223
MAX WIND SPEED: 28 KNOTS
DIRECTION: 130 DEG
DAY: 27
HOUR: 21

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 221

| HEIGHT (M) | <1 | 1-1.5 | 2-2.5 | 3-3.5 | 4-5.5 | 6-7.5 | 8-8.5 | >8.5 | MEAN | MAX (DA HR) |
|---|---|---|---|---|---|---|---|---|---|---|
| % FREQUENCY | 14.5 | 60.6 | 18.7 | 6.8 | 1.4 | | | | 1.5M | 4.0M (08 21) |

JANUARY D A T A S U M M A R Y 42003
AVERAGE LATITUDE 26.0N AVERAGE LONGITUDE 088.0W

| MEANS AND EXTREMES | MIN | (DA HR) | MEAN | MAX | (DA HR) | NO. OF OBS | DAYS WITH DATA |
|---|---|---|---|---|---|---|---|
| AIR TEMP (DEG C) | 13.5 | (08 21) | 19.8 | 25.9 | (01 15) | 247 | 31 |
| SEA TEMP (DEG C) | 19.2 | (13 08) | 22.8 | 29.9 | (01 00) | 246 | 31 |
| AIR-SEA TEMP (DEG C) | -09.3 | (19 18) | -04.0 | 02.4 | (25 21) | 246 | 31 |
| PRESSURE (MBAR) | 1004.5 | (25 21) | 1018.9 | 1029.2 | (11 15) | 247 | 31 |

WIND - % FREQUENCIES, MEANS AND EXTREMES

| DIR | SPEED (KNOTS) <4 | 4-10 | 11-21 | 22-33 | 34-47 | >47 | TOTAL % | MEAN SPEED (KNOTS) |
|---|---|---|---|---|---|---|---|---|
| N | | 7.7 | 18.6 | | | | 26.3 | 11.9 |
| NE | | 6.9 | 8.9 | | | | 15.8 | 10.7 |
| E | .4 | 5.8 | 5.3 | | | | 11.5 | 9.8 |
| SE | | 3.8 | 5.3 | .4 | | | 9.3 | 12.4 |
| S | .8 | | 4.8 | .4 | | | 6.1 | 15.6 |
| SW | .8 | .8 | 1.2 | .4 | | | 3.2 | 9.3 |
| W | | 2.0 | 2.0 | 2.4 | | | 6.5 | 16.9 |
| NW | .8 | 2.8 | 8.1 | 4.5 | | | 16.2 | 16.5 |
| CALM | .4 | | | | | | .4 | .0 |
| TOTAL % | 3.2 | 30.8 | 57.9 | 8.1 | | | 100.0 | 12.8 |

NO. OF WAVE OBS: 236
MAX WIND SPEED: 33 KNOTS
DIRECTION: 320 DEG
DAY: 18
HOUR:

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 236

| HEIGHT (M) | <1 | 1-1.5 | 2-2.5 | 3-3.5 | 4-5.5 | 6-7.5 | 8-9.5 | >9.5 | MEAN | MAX (DA HR) |
|---|---|---|---|---|---|---|---|---|---|---|
| % FREQUENCY | 9.7 | 53.0 | 23.3 | 8.1 | 6.0 | | | | 1.7M | 5.0M (08 09) |

FEBRUARY D A T A S U M M A R Y 42003
AVERAGE LATITUDE 26.0N AVERAGE LONGITUDE 088.0W

| MEANS AND EXTREMES | MIN | (DA HR) | MEAN | MAX | (DA HR) | NO. OF OBS | DAYS WITH DATA |
|---|---|---|---|---|---|---|---|
| AIR TEMP (DEG C) | 11.0 | (23 00) | 18.0 | 25.0 | (16 09) | 221 | 28 |
| SEA TEMP (DEG C) | 18.0 | (11 09) | 22.1 | 25.3 | (28 15) | 211 | 28 |
| AIR-SEA TEMP (DEG C) | -12.0 | (22 18) | -04.1 | 01.4 | (18 09) | 211 | 28 |
| PRESSURE (MBAR) | 1005.8 | (08 21) | 1017.7 | 1028.5 | (22 15) | 221 | 28 |

WIND - % FREQUENCIES, MEANS AND EXTREMES

| DIR | SPEED (KNOTS) <4 | 4-10 | 11-21 | 22-33 | 34-47 | >47 | TOTAL % | MEAN SPEED (KNOTS) |
|---|---|---|---|---|---|---|---|---|
| N | .9 | 9.5 | 15.1 | .9 | | | 26.4 | 12.0 |
| NE | 1.4 | 8.6 | 9.0 | | | | 19.0 | 10.8 |
| E | | 5.4 | 10.4 | .5 | | | 16.3 | 12.8 |
| SE | .9 | 5.0 | 6.8 | | | | 12.7 | 10.9 |
| S | | .5 | 5.0 | .5 | | | 5.9 | 16.7 |
| SW | .5 | 1.4 | .9 | | | | 2.7 | 7.8 |
| W | .5 | 1.4 | 2.3 | | | | 4.1 | 10.1 |
| NW | .5 | 4.1 | 12.4 | 1.4 | | | 18.3 | 12.2 |
| CALM | .5 | | | | | | .5 | |
| TOTAL % | 5.4 | 35.5 | 57.9 | 3.2 | | | 100.0 | 12.0 |

NO. OF OBS: 221
MAX WIND SPEED: 27 KNOTS
DIRECTION: 320 DEG
DAY: 22
HOUR: 03

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 208

| HEIGHT (M) | <1 | 1-1.5 | 2-2.5 | 3-3.5 | 4-5.5 | 6-7.5 | 8-9.5 | >9.5 | MEAN | MAX (DA HR) |
|---|---|---|---|---|---|---|---|---|---|---|
| % FREQUENCY | 21.2 | 48.0 | 24.5 | 4.3 | 1.0 | | | | 1.4M | 4.0M (22 12) |

JANUARY D A T A S U M M A R Y 44002
AVERAGE LATITUDE 40.1N AVERAGE LONGITUDE 073.0W

| MEANS AND EXTREMES | MIN | (DA HR) | MEAN | MAX | (DA HR) | NO. OF OBS | DAYS WITH DATA |
|---|---|---|---|---|---|---|---|
| AIR TEMP (DEG C) | -07.5 | (10 12) | 01.5 | 15.2 | (26 12) | 244 | 31 |
| SEA TEMP (DEG C) | 05.3 | (30 12) | 07.3 | 09.5 | (02 06) | 244 | 31 |
| AIR-SEA TEMP (DEG C) | -15.4 | (10 12) | -06.1 | 00.6 | (28 12) | 244 | 31 |
| PRESSURE (MBAR) | 0976.3 | (26 12) | 1015.9 | 1034.0 | (04 15) | 244 | 31 |

WIND - % FREQUENCIES, MEANS AND EXTREMES

| DIR | SPEED (KNOTS) <4 | 4-10 | 11-21 | 22-33 | 34-47 | >47 | TOTAL % | MEAN SPEED (KNOTS) |
|---|---|---|---|---|---|---|---|---|
| N | | .4 | 3.4 | 1.3 | | | 5.1 | 16.1 |
| NE | | 1.7 | 3.8 | 5.0 | .4 | | 8.9 | 18.0 |
| E | | 1.7 | 5.1 | 1.7 | .4 | | 8.9 | 17.0 |
| SE | .4 | | 2.1 | 2.1 | | | 4.5 | 18.2 |
| S | | 1.3 | 2.1 | 1.3 | .4 | | 5.1 | 17.4 |
| SW | | .8 | 5.1 | 4.2 | | | 10.2 | 18.9 |
| W | .8 | 3.0 | 23.7 | 16.1 | .8 | | 44.5 | 19.0 |
| NW | .4 | 1.7 | 7.2 | 3.4 | | | 12.7 | 17.3 |
| CALM | .4 | | | | | | .4 | |
| TOTAL % | 1.7 | 10.6 | 62.6 | 33.1 | 2.1 | | 100.0 | 18.5 |

% OF OBS WITH POTENTIAL SUPERSTRUCTURE ICING: MODERATE:27.1% SEVERE: NONE #OBS: 236

FEBRUARY D A T A S U M M A R Y 44002
AVERAGE LATITUDE 40.1N AVERAGE LONGITUDE 073.0W

| MEANS AND EXTREMES | MIN | (DA HR) | MEAN | MAX | (DA HR) | NO. OF OBS | DAYS WITH DATA |
|---|---|---|---|---|---|---|---|
| AIR TEMP (DEG C) | -08.1 | (04 15) | -03.0 | 02.2 | (08 21) | 48 | 6 |
| SEA TEMP (DEG C) | 05.6 | (06 06) | 08.2 | 08.6 | (03 18) | 48 | 6 |
| AIR-SEA TEMP (DEG C) | -14.4 | (04 15) | -09.2 | -03.5 | (08 21) | 48 | 6 |
| PRESSURE (MBAR) | 0980.6 | (08 21) | 1026.2 | 1036.0 | (04 15) | 48 | 6 |

WIND - % FREQUENCIES, MEANS AND EXTREMES

| DIR | SPEED (KNOTS) <4 | 4-10 | 11-21 | 22-33 | 34-47 | >47 | TOTAL % | MEAN SPEED (KNOTS) |
|---|---|---|---|---|---|---|---|---|
| N | 2.5 | 5.0 | 31.8 | | | | 39.3 | 13.7 |
| NE | | 9.1 | 9.1 | 9.8 | 2.3 | | 27.3 | 18.9 |
| E | | | 4.5 | | | | 4.5 | 18.0 |
| SE | | | | | | | | |
| S | | | | | | | | |
| SW | | | | | | | | |
| W | | | 6.8 | | | | 6.8 | 13.4 |
| NW | | | 20.5 | | | | 20.5 | 16.9 |
| CALM | | | | | | | | |
| TOTAL % | 2.5 | 19.9 | 72.7 | 9.8 | 2.3 | | 100.0 | 15.8 |

% OF OBS WITH POTENTIAL SUPERSTRUCTURE ICING: MODERATE:83.8% SEVERE: NONE #OBS: 44

JANUARY D A T A S U M M A R Y 44003
AVERAGE LATITUDE 40.8N AVERAGE LONGITUDE 068.9W

| MEANS AND EXTREMES | MIN | (DA HR) | MEAN | MAX | (DA HR) | NO. OF OBS | DAYS WITH DATA |
|---|---|---|---|---|---|---|---|
| AIR TEMP (DEG C) | -04.2 | (30 18) | 01.9 | 11.6 | (28 15) | 99 | 7 |
| SEA TEMP (DEG C) | 05.5 | (31 18) | 05.9 | 06.3 | (27 19) | 99 | 7 |
| AIR-SEA TEMP (DEG C) | -09.9 | (30 15) | -04.0 | 05.6 | (28 15) | 99 | 7 |
| PRESSURE (MBAR) | 0991.9 | (28 18) | 1007.2 | 1023.6 | (25 03) | 99 | 7 |

WIND - % FREQUENCIES, MEANS AND EXTREMES

| DIR | SPEED (KNOTS) <4 | 4-10 | 11-21 | 22-33 | 34-47 | >47 | TOTAL % | MEAN SPEED (KNOTS) |
|---|---|---|---|---|---|---|---|---|
| N | | | | | | | | |
| NE | | | | | | | | |
| E | | | | | | | | |
| SE | | | | | | | | |
| S | | 1.9 | 18.5 | 5.6 | | | 25.9 | 18.5 |
| SW | | | 7.4 | 1.9 | | | 9.3 | 18.8 |
| W | | 1.9 | 33.3 | 9.3 | 1.9 | | 46.3 | 19.3 |
| NW | | 1.9 | 18.7 | | | | 18.5 | 15.0 |
| CALM | | | | | | | | |
| TOTAL % | | 5.6 | 75.9 | 16.7 | 1.9 | | 100.0 | 17.3 |

NO. OF OBS: 54
MAX WIND SPEED: 39 KNOTS
DIRECTION: 290 DEG
DAY: 30
HOUR: 21

% OF OBS WITH POTENTIAL SUPERSTRUCTURE ICING: MODERATE:22.2% SEVERE: NONE #OBS: 54

FEBRUARY D A T A S U M M A R Y 44003
AVERAGE LATITUDE 40.6N AVERAGE LONGITUDE 068.9W

| MEANS AND EXTREMES | MIN | (DA HR) | MEAN | MAX | (DA HR) | NO. OF OBS | DAYS WITH DATA |
|---|---|---|---|---|---|---|---|
| AIR TEMP (DEG C) | -05.5 | (04 18) | 00.0 | 08.6 | (07 03) | 160 | 23 |
| SEA TEMP (DEG C) | 03.8 | (16 12) | 04.5 | 05.6 | (01 09) | 161 | 23 |
| AIR-SEA TEMP (DEG C) | -10.5 | (04 18) | -04.5 | 01.7 | (07 03) | 160 | 23 |
| PRESSURE (MBAR) | 0991.9 | (07 18) | 1014.2 | 1030.0 | (09 15) | 160 | 23 |

WIND - % FREQUENCIES, MEANS AND EXTREMES

| DIR | SPEED (KNOTS) <4 | 4-10 | 11-21 | 22-33 | 34-47 | >47 | TOTAL % | MEAN SPEED (KNOTS) |
|---|---|---|---|---|---|---|---|---|
| N | 2.4 | 5.9 | 10.6 | 2.8 | | | 21.8 | 13.8 |
| NE | 1.8 | 3.5 | 1.8 | | | | 7.1 | 7.3 |
| E | 1.2 | 4.1 | 1.8 | 1.2 | .6 | | 8.9 | 13.1 |
| SE | .6 | 1.2 | .6 | | | | 2.4 | 9.9 |
| S | | 2.4 | | | | | 2.4 | 8.8 |
| SW | 1.2 | 2.8 | | | | | 4.7 | 8.4 |
| W | .6 | 5.9 | 4.1 | | | | 10.6 | 10.2 |
| NW | 4.1 | 6.8 | 29.4 | 2.9 | | | 42.4 | 12.9 |
| CALM | | | | | | | | |
| TOTAL % | 11.8 | 31.8 | 48.8 | 7.1 | .6 | | 100.0 | 11.4 |

NO. OF OBS: 159
MAX WIND SPEED: 35 KNOTS
DIRECTION: 080 DEG
DAY: 06
HOUR: 21

% OF OBS WITH POTENTIAL SUPERSTRUCTURE ICING: MODERATE:12.4% SEVERE: NONE #OBS: 170

JANUARY D A T A S U M M A R Y 44004

AVERAGE LATITUDE 58.0N AVERAGE LONGITUDE 070.0W

| MEANS AND EXTREMES | MIN | (DA HR) | MEAN | MAX | (DA HR) | NO. OF OBS | DAYS WITH DATA |
|---|---|---|---|---|---|---|---|
| AIR TEMP (DEG C) | -05.0 | (10 15) | 05.2 | 15.2 | (26 12) | 248 | 31 |
| SEA TEMP (DEG C) | 08.2 | (01 00) | 08.6 | 11.3 | (07 18) | 248 | 31 |
| AIR-SEA TEMP (DEG C) | -13.1 | (10 15) | -03.4 | 05.5 | (26 12) | 248 | 31 |
| PRESSURE (MBAR) | 0986.5 | (09 18) | 1017.1 | 1033.8 | (17 15) | 248 | 31 |

WIND - % FREQUENCIES, MEANS AND EXTREMES

| DIR | SPEED (KNOTS) <4 | 4-10 | 11-21 | 22-33 | 34-47 | >47 | TOTAL % | MEAN SPEED (KNOTS) | NO. OF OBS: 248 |
|---|---|---|---|---|---|---|---|---|---|
| N | | .4 | 2.4 | .8 | | | 3.6 | 16.9 | MAX WIND |
| NE | | 1.6 | .8 | 3.6 | | | 6.0 | 19.3 | SPEED: 43 KNOTS |
| E | | 2.8 | 5.6 | 2.0 | .8 | | 11.3 | 17.3 | DIRECTION: 240 DEG |
| SE | | 1.6 | 3.6 | 4.4 | .4 | | 10.1 | 21.1 | DAY: 09 |
| S | .4 | .8 | 2.4 | 1.2 | | | 4.8 | 15.2 | HOUR: 21 |
| SW | | 2.4 | 9.0 | 2.8 | 1.6 | | 15.9 | 20.8 | |
| W | 1.2 | 9.2 | 11.3 | 10.8 | 3.6 | | 36.1 | 22.2 | |
| NW | .4 | .8 | 7.3 | 5.6 | | | 14.1 | 20.0 | |
| CALM | 4 | | | | | | .4 | 0 | |
| TOTAL % | 2.0 | 13.7 | 37.5 | 40.3 | 6.9 | | 100.0 | 20.4 | |

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) NO. OF WAVE OBS: 186

| HEIGHT (M) | <1 | 1-1.5 | 2-2.5 | 3-3.5 | 4-5.5 | 6-7.5 | 8-9.5 | >9.5 | MEAN | MAX (DA HR) |
|---|---|---|---|---|---|---|---|---|---|---|
| % FREQUENCY | | 5.9 | 27.4 | 25.8 | 20.3 | 14.0 | .5 | | 3.7M | 8.0M (10 06) |

% OF OBS WITH POTENTIAL SUPERSTRUCTURE ICING MODERATE: 4.0% SEVERE: NONE OBS: 248

FEBRUARY D A T A S U M M A R Y 44004

AVERAGE LATITUDE 58.0N AVERAGE LONGITUDE 070.0W

| MEANS AND EXTREMES | MIN | (DA HR) | MEAN | MAX | (DA HR) | NO. OF OBS | DAYS WITH DATA |
|---|---|---|---|---|---|---|---|
| AIR TEMP (DEG C) | -09.0 | (04 18) | 02.1 | 09.4 | (06 18) | 224 | 28 |
| SEA TEMP (DEG C) | 08.2 | (08 00) | 08.7 | 12.4 | (26 15) | 224 | 28 |
| AIR-SEA TEMP (DEG C) | -12.4 | (22 18) | -07.6 | 05.1 | (08 15) | 224 | 28 |
| PRESSURE (MBAR) | 0981.3 | (07 15) | 1014.0 | 1032.0 | (04 15) | 224 | 28 |

WIND - % FREQUENCIES, MEANS AND EXTREMES

| DIR | SPEED (KNOTS) <4 | 4-10 | 11-21 | 22-33 | 34-47 | >47 | TOTAL % | MEAN SPEED (KNOTS) | NO. OF OBS: 224 |
|---|---|---|---|---|---|---|---|---|---|
| N | | | 4.5 | 21.0 | 2.2 | | 28.0 | 15.8 | MAX WIND |
| NE | | .4 | 4.0 | 3.6 | 1.3 | | 9.4 | 12.8 | SPEED: 42 KNOTS |
| E | | .4 | 2.2 | 4.0 | 1.8 | .9 | 9.4 | 18.6 | DIRECTION: 080 DEG |
| SE | | | | | | | | | DAY: 08 |
| S | | .8 | | | | | .8 | 1.5 | HOUR: 19 |
| SW | | | | 2.7 | | | 2.7 | 20.0 | |
| W | | 1.5 | 1.8 | 6.3 | 8.0 | .9 | 18.3 | 19.7 | |
| NW | | .4 | 3.1 | 17.4 | 8.9 | .4 | 30.4 | 19.4 | |
| CALM | | .4 | | | | | .4 | 0 | |
| TOTAL % | | 4.0 | 15.6 | 53.1 | 25.0 | 2.2 | 100.0 | 17.3 | |

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) NO. OF WAVE OBS: 77

| HEIGHT (M) | <1 | 1-1.5 | 2-2.5 | 3-3.5 | 4-5.5 | 6-7.5 | 8-9.5 | >9.5 | MEAN | MAX (DA HR) |
|---|---|---|---|---|---|---|---|---|---|---|
| % FREQUENCY | | 5.2 | 50.6 | 23.4 | 13.0 | 7.8 | | | 3.0M | 6.5M (07 15) |

% OF OBS WITH POTENTIAL SUPERSTRUCTURE ICING MODERATE: 5.8% SEVERE: NONE OBS: 224

JANUARY D A T A S U M M A R Y 46001

AVERAGE LATITUDE 58.0N AVERAGE LONGITUDE 147.9W

| MEANS AND EXTREMES | MIN | (DA HR) | MEAN | MAX | (DA HR) | NO. OF OBS | DAYS WITH DATA |
|---|---|---|---|---|---|---|---|
| AIR TEMP (DEG C) | -01.2 | (07 21) | 03.1 | 04.6 | (08 15) | 247 | 31 |
| SEA TEMP (DEG C) | 03.1 | (28 18) | 03.5 | 03.8 | (31 21) | 247 | 31 |
| AIR-SEA TEMP (DEG C) | -04.4 | (07 21) | -00.1 | 01.4 | (08 15) | 247 | 31 |
| PRESSURE (MBAR) | 0970.8 | (08 18) | 1004.4 | 1027.0 | (01 21) | 247 | 31 |

WIND - % FREQUENCIES, MEANS AND EXTREMES

| DIR | SPEED (KNOTS) <4 | 4-10 | 11-21 | 22-33 | 34-47 | >47 | TOTAL % | MEAN SPEED (KNOTS) | NO. OF OBS: 247 |
|---|---|---|---|---|---|---|---|---|---|
| N | | | 2.8 | | | | 2.8 | 7.6 | MAX WIND |
| NE | | .4 | 2.4 | 5.7 | | 2.0 | 10.5 | 15.8 | SPEED: 40 KNOTS |
| E | | 1.2 | 2.8 | 28.7 | 13.4 | 1.2 | 46.3 | 18.8 | DIRECTION: 090 DEG |
| SE | | | 2.4 | 13.0 | 8.1 | .8 | 22.3 | 17.7 | DAY: 08 |
| S | | .4 | 1.2 | 6.5 | 4.0 | | 12.1 | 15.4 | HOUR: 05 |
| SW | | | | 3.6 | .4 | | 4.0 | 16.3 | |
| W | | | 1.2 | 2.4 | 1.6 | | 5.3 | 16.1 | |
| NW | | .4 | .4 | | | | .8 | 4.5 | |
| CALM | | | | | | | | 0 | |
| TOTAL % | | 2.4 | 13.4 | 59.3 | 21.9 | 4.0 | 100.0 | 17.3 | |

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) NO. OF WAVE OBS: 246

| HEIGHT (M) | <1 | 1-1.5 | 2-2.5 | 3-3.5 | 4-5.5 | 6-7.5 | 8-9.5 | >9.5 | MEAN | MAX (DA HR) |
|---|---|---|---|---|---|---|---|---|---|---|
| % FREQUENCY | | 9.3 | 46.5 | 31.7 | 11.0 | 1.6 | | | 2.8M | 7.0M (08 06) |

FEBRUARY D A T A S U M M A R Y 46001

AVERAGE LATITUDE 58.0N AVERAGE LONGITUDE 147.9W

| MEANS AND EXTREMES | MIN | (DA HR) | MEAN | MAX | (DA HR) | NO. OF OBS | DAYS WITH DATA |
|---|---|---|---|---|---|---|---|
| AIR TEMP (DEG C) | -06.0 | (07 21) | 02.0 | 04.7 | (23 06) | 221 | 28 |
| SEA TEMP (DEG C) | 03.0 | (22 15) | 03.2 | 03.6 | (01 08) | 223 | 28 |
| AIR-SEA TEMP (DEG C) | -10.1 | (07 21) | -01.1 | 01.6 | (23 06) | 220 | 28 |
| PRESSURE (MBAR) | 0964.4 | (05 21) | 0999.6 | 1022.6 | (26 06) | 224 | 28 |

WIND - % FREQUENCIES, MEANS AND EXTREMES

| DIR | SPEED (KNOTS) <4 | 4-10 | 11-21 | 22-33 | 34-47 | >47 | TOTAL % | MEAN SPEED (KNOTS) | NO. OF OBS: 224 |
|---|---|---|---|---|---|---|---|---|---|
| N | | | .9 | 2.2 | .4 | | 3.6 | 13.8 | MAX WIND |
| NE | | | 3.1 | 2.2 | | | 5.4 | 9.7 | SPEED: 43 KNOTS |
| E | | .4 | 6.3 | 11.6 | 7.6 | 2.2 | 28.1 | 18.9 | DIRECTION: 150 DEG |
| SE | | | 2.2 | 12.5 | 11.2 | 1.3 | 27.2 | 21.4 | DAY: 22 |
| S | | .4 | 2.2 | 6.3 | 8.0 | 1.3 | 18.1 | 20.6 | HOUR: 09 |
| SW | | | .9 | 3.1 | .4 | | 4.6 | 14.7 | |
| W | | | .9 | 4.5 | 3.6 | | 8.9 | 18.9 | |
| NW | | | 1.3 | .9 | 2.2 | .4 | 4.8 | 20.5 | |
| CALM | | .9 | | | | | .9 | 0 | |
| TOTAL % | | 2.2 | 17.8 | 42.4 | 32.1 | 4.4 | 100.0 | 18.9 | |

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) NO. OF WAVE OBS: 222

| HEIGHT (M) | <1 | 1-1.5 | 2-2.5 | 3-3.5 | 4-5.5 | 6-7.5 | 8-9.5 | >9.5 | MEAN | MAX (DA HR) |
|---|---|---|---|---|---|---|---|---|---|---|
| % FREQUENCY | | 8.3 | 18.4 | 34.2 | 33.8 | 5.0 | .5 | | 3.6M | 8.9M (22 12) |

% OF OBS WITH POTENTIAL SUPERSTRUCTURE ICING MODERATE: 7.7% SEVERE: NONE OBS: 221

JANUARY D A T A S U M M A R Y 46002

AVERAGE LATITUDE 42.5N AVERAGE LONGITUDE 130.0W

| MEANS AND EXTREMES | MIN | (DA HR) | MEAN | MAX | (DA HR) | NO. OF OBS | DAYS WITH DATA |
|---|---|---|---|---|---|---|---|
| AIR TEMP (DEG C) | 07.8 | (05 21) | 11.1 | 13.0 | (13 09) | 246 | 31 |
| PRESSURE (MBAR) | 0978.0 | (05 00) | 1008.7 | 1029.0 | (23 18) | 246 | 31 |

WIND - % FREQUENCIES, MEANS AND EXTREMES

| DIR | SPEED (KNOTS) <4 | 4-10 | 11-21 | 22-33 | 34-47 | >47 | TOTAL % | MEAN SPEED (KNOTS) | NO. OF OBS: 244 |
|---|---|---|---|---|---|---|---|---|---|
| N | | .4 | .4 | .8 | | | 1.6 | 9.1 | MAX WIND |
| NE | | .4 | | .4 | | | .8 | 6.5 | SPEED: 32 KNOTS |
| E | | | 1.2 | 1.2 | 3.7 | | 6.1 | 20.0 | DIRECTION: 160 DEG |
| SE | | .4 | 3.3 | 11.9 | 4.9 | | 20.5 | 17.2 | DAY: 07 |
| S | | 1.2 | 3.7 | 10.2 | 10.6 | | 25.8 | 18.4 | HOUR: 09 |
| SW | | .4 | 4.5 | 9.8 | .4 | | 15.2 | 13.2 | |
| W | | 1.2 | 6.6 | 10.2 | 2.0 | | 20.1 | 13.1 | |
| NW | | 1.2 | 3.3 | 2.9 | | | 7.4 | 9.2 | |
| CALM | | .8 | | | | | .8 | 0 | |
| TOTAL % | | 5.1 | 23.0 | 53.3 | 17.6 | | 100.0 | 14.8 | |

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) NO. OF WAVE OBS: 245

| HEIGHT (M) | <1 | 1-1.5 | 2-2.5 | 3-3.5 | 4-5.5 | 6-7.5 | 8-9.5 | >9.5 | MEAN | MAX (DA HR) |
|---|---|---|---|---|---|---|---|---|---|---|
| % FREQUENCY | | | 4.5 | 29.4 | 36.3 | 29.0 | .8 | | 3.2M | 6.0M (18 12) |

FEBRUARY D A T A S U M M A R Y 46002

AVERAGE LATITUDE 42.5N AVERAGE LONGITUDE 130.0W

| MEANS AND EXTREMES | MIN | (DA HR) | MEAN | MAX | (DA HR) | NO. OF OBS | DAYS WITH DATA |
|---|---|---|---|---|---|---|---|
| AIR TEMP (DEG C) | 04.6 | (09 06) | 10.0 | 12.5 | (05 00) | 221 | 28 |
| PRESSURE (MBAR) | 0980.0 | (09 18) | 1010.9 | 1026.9 | (15 18) | 221 | 28 |

WIND - % FREQUENCIES, MEANS AND EXTREMES

| DIR | SPEED (KNOTS) <4 | 4-10 | 11-21 | 22-33 | 34-47 | >47 | TOTAL % | MEAN SPEED (KNOTS) | NO. OF OBS: 220 |
|---|---|---|---|---|---|---|---|---|---|
| N | | | | | | | 5.0 | 9.9 | MAX WIND |
| NE | | | | | | | 4.5 | 8.1 | SPEED: 40 KNOTS |
| E | | | .5 | .5 | | | .9 | 11.1 | DIRECTION: 180 DEG |
| SE | | | .5 | 2.7 | 1.8 | | 5.0 | 20.6 | DAY: 04 |
| S | | | 9.8 | 27.3 | 9.8 | 1.4 | 39.1 | 19.9 | HOUR: 21 |
| SW | | | 2.3 | 8.2 | 4.1 | | 14.5 | 18.3 | |
| W | | | .9 | 10.5 | 6.8 | .5 | 18.6 | 19.9 | |
| NW | | | 4.1 | 7.7 | 4.5 | | 16.4 | 15.7 | |
| CALM | | | | | | | 2.5 | 0 | |
| TOTAL % | | | 20.0 | 60.9 | 17.7 | 1.8 | 100.0 | 19.9 | |

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) NO. OF WAVE OBS: 218

| HEIGHT (M) | <1 | 1-1.5 | 2-2.5 | 3-3.5 | 4-5.5 | 6-7.5 | 8-9.5 | >9.5 | MEAN | MAX (DA HR) |
|---|---|---|---|---|---|---|---|---|---|---|
| % FREQUENCY | | | 8.4 | 31.2 | 28.9 | 28.8 | 3.7 | | 3.3M | 6.5M (08 21) |

JANUARY D A T A S U M M A R Y 46003

AVERAGE LATITUDE 52.0N AVERAGE LONGITUDE 156.0W

| MEANS AND EXTREMES | MIN | (DA HR) | MEAN | MAX | (DA HR) | NO. OF OBS | DAYS WITH DATA |
|---|---|---|---|---|---|---|---|
| AIR TEMP (DEG C) | 00.3 | (08 06) | 02.7 | 04.6 | (22 06) | 248 | 31 |
| SEA TEMP (DEG C) | 03.3 | (03 21) | 03.4 | 04.0 | (22 06) | 248 | 31 |
| AIR-SEA TEMP (DEG C) | -03.1 | (08 06) | -00.7 | 01.4 | (22 06) | 248 | 31 |
| PRESSURE (MBAR) | 0965.3 | (08 15) | 0995.3 | 1015.3 | (02 09) | 248 | 31 |

WIND - % FREQUENCIES, MEANS AND EXTREMES

| DIR | SPEED (KNOTS) <4 | 4-10 | 11-21 | 22-33 | 34-47 | >47 | TOTAL % | MEAN SPEED (KNOTS) | NO. OF OBS: 248 |
|---|---|---|---|---|---|---|---|---|---|
| N | .4 | 2.8 | 10.6 | 1.6 | .4 | | 15.7 | 15.3 | MAX WIND |
| NE | .8 | 2.0 | 2.0 | .4 | 1.6 | | 6.9 | 16.1 | SPEED: 38 KNOTS |
| E | .4 | 1.6 | 8.5 | 14.5 | | | 25.0 | 21.1 | DIRECTION: 120 DEG |
| SE | | 2.4 | 8.9 | 2.8 | .8 | | 14.9 | 17.2 | DAY: 21 |
| S | .4 | 2.8 | 6.0 | 2.4 | | | 11.7 | 15.7 | HOUR: 21 |
| SW | .4 | 2.0 | 4.4 | 1.2 | | | 8.1 | 14.3 | |
| W | 1.2 | 3.2 | 4.0 | | | | 8.5 | 11.4 | |
| NW | 1.2 | 2.0 | 6.0 | | | | 9.3 | 12.1 | |
| CALM | 1 | | | | | | 1 | 0 | |
| TOTAL % | 4.8 | 19.0 | 50.4 | 23.0 | 2.8 | | 100.0 | 16.5 | |

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) NO. OF WAVE OBS: 249

| HEIGHT (M) | <1 | 1-1.5 | 2-2.5 | 3-3.5 | 4-5.5 | 6-7.5 | 8-9.5 | >9.5 | MEAN | MAX (DA HR) |
|---|---|---|---|---|---|---|---|---|---|---|
| % FREQUENCY | | | 27.4 | 43.5 | 25.4 | 3.6 | | | 3.4M | 7.5M (08 12) |

FEBRUARY D A T A S U M M A R Y 46003

AVERAGE LATITUDE 52.0N AVERAGE LONGITUDE 156.0W

| MEANS AND EXTREMES | MIN | (DA HR) | MEAN | MAX | (DA HR) | NO. OF OBS | DAYS WITH DATA |
|---|---|---|---|---|---|---|---|
| AIR TEMP (DEG C) | -07.2 | (07 18) | 01.4 | 04.4 | (22 18) | 224 | 28 |
| SEA TEMP (DEG C) | 02.8 | (13 06) | 03.0 | 03.7 | (28 06) | 224 | 28 |
| AIR-SEA TEMP (DEG C) | -10.4 | (07 18) | -01.6 | 01.5 | (22 18) | 224 | 28 |
| PRESSURE (MBAR) | 0980.2 | (13 06) | 0997.9 | 1012.8 | (27 21) | 224 | 28 |

WIND - % FREQUENCIES, MEANS AND EXTREMES

| DIR | SPEED (KNOTS) <4 | 4-10 | 11-21 | 22-33 | 34-47 | >47 | TOTAL % | MEAN SPEED (KNOTS) | NO. OF OBS: 224 |
|---|---|---|---|---|---|---|---|---|---|
| N | | | 2.7 | 4.5 | .4 | | 7.6 | 11.9 | MAX WIND |
| NE | | | .4 | 2.7 | 3.6 | .4 | 7.1 | 21.0 | SPEED: 43 KNOTS |
| E | | | .8 | 5.8 | 16.5 | .4 | 23.7 | 22.0 | DIRECTION: 250 DEG |
| SE | | .4 | 1.3 | 5.8 | 5.8 | .9 | 14.3 | 21.0 | DAY: 22 |
| S | | | 1.3 | 6.7 | 2.2 | | 10.3 | 18.4 | HOUR: 03 |
| SW | | .4 | .4 | 7.6 | 2.2 | 1.8 | 12.5 | 18.8 | |
| W | | .4 | .4 | 2.2 | 5.0 | .9 | 9.0 | 24.0 | |
| NW | | | 4.0 | 1.8 | 8.5 | 2.2 | 16.5 | 23.1 | |
| CALM | | | | | | | | | |
| TOTAL % | | 1.3 | 11.8 | 37.1 | 43.3 | 6.7 | 100.0 | 20.8 | |

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) NO. OF WAVE OBS: 224

| HEIGHT (M) | <1 | 1-1.5 | 2-2.5 | 3-3.5 | 4-5.5 | 6-7.5 | 8-9.5 | >9.5 | MEAN | MAX (DA HR) |
|---|---|---|---|---|---|---|---|---|---|---|
| % FREQUENCY | | .8 | 18.3 | 39.7 | 38.3 | 3.0 | | | 3.0M | 7.0M (25 00) |

% OF OBS WITH POTENTIAL SUPERSTRUCTURE ICING MODERATE: 8.4% SEVERE: NONE OBS: 224

JANUARY D A T A S U M M A R Y 46005

AVERAGE LATITUDE 48.0N AVERAGE LONGITUDE 131.0W

| MEANS AND EXTREMES | MIN | (DA HR) | MEAN | MAX | (DA HR) | NO. OF OBS | DAYS WITH DATA |
|---|---|---|---|---|---|---|---|
| AIR TEMP (DEG C) | 04.0 | (05 18) | 08.5 | 11.5 | (07 18) | 238 | 31 |
| SEA TEMP (DEG C) | 08.0 | (01 00) | 08.8 | 10.4 | (13 21) | 238 | 31 |
| AIR-SEA TEMP (DEG C) | -05.4 | (05 18) | -00.2 | 01.8 | (07 18) | 238 | 31 |
| PRESSURE (MBAR) | 0982.6 | (19 03) | 1007.7 | 1026.6 | (23 18) | 238 | 31 |

WIND - % FREQUENCIES, MEANS AND EXTREMES

| DIR | SPEED (KNOTS) <4 | 4-10 | 11-21 | 22-33 | 34-47 | >47 | TOTAL % | MEAN SPEED (KNOTS) | NO. OF OBS: 238 |
|---|---|---|---|---|---|---|---|---|---|
| N | | | .4 | 1.7 | | | 2.1 | 26.8 | MAX WIND |
| NE | | | .4 | | | | .4 | 9.5 | SPEED: 39 KNOTS |
| E | | | 1.7 | 7.1 | 9.7 | .4 | 18.9 | 21.3 | DIRECTION: 090 DEG |
| SE | | .4 | 2.1 | 11.3 | 10.1 | | 23.9 | 19.4 | DAY: 13 |
| S | | .4 | 7.6 | 12.2 | 5.4 | | 25.5 | 16.2 | HOUR: 05 |
| SW | | | 5.5 | 7.6 | .9 | | 13.9 | 13.3 | |
| W | | 1.3 | 4.2 | 5.0 | .4 | | 9.7 | 10.0 | |
| NW | | | .4 | 5.5 | 1.3 | | 7.1 | 17.6 | |
| CALM | | | | | | | | | |
| TOTAL % | | 2.1 | 21.8 | 48.3 | 27.3 | .4 | 100.0 | 16.6 | |

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) NO. OF WAVE OBS: 236

| HEIGHT (M) | <1 | 1-1.5 | 2-2.5 | 3-3.5 | 4-5.5 | 6-7.5 | 8-9.5 | >9.5 | MEAN | MAX (DA HR) |
|---|---|---|---|---|---|---|---|---|---|---|
| % FREQUENCY | | .8 | 27.3 | 54.2 | 17.8 | | | | 3.2M | 5.5M (19 15) |

FEBRUARY D A T A S U M M A R Y 46005

AVERAGE LATITUDE 48.0N AVERAGE LONGITUDE 131.0W

| MEANS AND EXTREMES | MIN | (DA HR) | MEAN | MAX | (DA HR) | NO. OF OBS | DAYS WITH DATA |
|---|---|---|---|---|---|---|---|
| AIR TEMP (DEG C) | 03.7 | (08 21) | 08.7 | 11.3 | (05 03) | 208 | 28 |
| SEA TEMP (DEG C) | 08.9 | (28 15) | 09.3 | 09.8 | (07 00) | 211 | 28 |
| AIR-SEA TEMP (DEG C) | -05.6 | (08 21) | -00.6 | 01.8 | (05 03) | 208 | 28 |
| PRESSURE (MBAR) | 0970.4 | (07 09) | 1008.8 | 1028.0 | (22 21) | 209 | 28 |

WIND - % FREQUENCIES, MEANS AND EXTREMES

| DIR | SPEED (KNOTS) <4 | 4-10 | 11-21 | 22-33 | 34-47 | >47 | TOTAL % | MEAN SPEED (KNOTS) | NO. OF OBS: 210 |
|---|---|---|---|---|---|---|---|---|---|
| N | | | 5.7 | 7.5 | 3.8 | | 18.1 | 14.0 | MAX WIND |
| NE | | | 1.0 | 2.4 | 4.8 | | 8.1 | 20.8 | SPEED: 40 KNOTS |
| E | | .5 | | .5 | | | 1.0 | 9.5 | DIRECTION: 310 DEG |
| SE | | | 1.0 | 2.4 | 6.7 | | 10.0 | 22.8 | DAY: 08 |
| S | | | 1.9 | 18.7 | 9.5 | | 30.1 | 18.3 | HOUR: 21 |
| SW | | .5 | 4.3 | 5.7 | 3.3 | .5 | 14.3 | 16.4 | |
| W | | | 1.0 | 11.0 | 4.3 | .5 | 16.7 | 18.8 | |
| NW | | | 1.0 | 2.4 | | .5 | 3.8 | 15.1 | |
| CALM | | | | | | | | | |
| TOTAL % | | 1.0 | 17.1 | 48.1 | 32.4 | 1.4 | 100.0 | 18.0 | |

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) NO. OF WAVE OBS: 209

| HEIGHT (M) | <1 | 1-1.5 | 2-2.5 | 3-3.5 | 4-5.5 | 6-7.5 | 8-9.5 | >9.5 | MEAN | MAX (DA HR) |
|---|---|---|---|---|---|---|---|---|---|---|
| % FREQUENCY | | | 1.9 | 25.8 | 40.7 | 31.6 | | | 3.4M | 5.5M (15 09) |

**Continued on page 300.**

# Selected Gale and Wave Observations, North Atlantic

## January and February 1978

| Vessel | Nationality | Date | Position of Ship Lat. deg. | Position of Ship Long. deg. | Time GMT | Wind Dir. 10° | Wind Speed kt. | Visibility n. mi. | Present Weather code | Pressure mb. | Temperature °C. Air | Temperature °C. Sea | Sea Waves* Period sec. | Sea Waves* Height ft. | Swell Waves Dir. 10° | Swell Waves Period sec. | Swell Waves Height ft. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NORTH ATLANTIC OCEAN | | JAN. | | | | | | | | | | | | | | | |
| YOUNG AMERICA | AMERICAN | 1 | 41.3 N | 55.4 W | 21 | 17 | 45 | 10 NM | 02 | 1007.8 | 17.8 | 17.8 | 5 | 6.5 | 18 | 9 | 13 |
| YOUNG AMERICA | AMERICAN | 2 | 41.1 N | 55.1 W | 00 | 17 | 45 | 10 NM | 02 | 1005.8 | 18.3 | 17.8 | | | | | |
| AMER ACCORD | AMERICAN | 5 | 42.0 N | 58.2 W | 00 | 30 | 50 | 5 NM | 83 | 1020.5 | 1.1 | 13.3 | 8 | 19.5 | | | |
| MONTICELLO VICTORY | AMERICAN | 8 | 25.0 N | 85.1 W | 18 | 20 | 45 | 10 NM | 02 | 1012.5 | 28.7 | 27.3 | 5 | 16.5 | | | |
| AFRICAN SUN | AMERICAN | 9 | 35.4 N | 73.9 W | 18 | 26 | 39 | .5 NM | | 999.0 | 10.0 | 21.1 | 10 | 13 | 23 | 12 | 10 |
| SANTA RITA | AMERICAN | 9 | 33.7 N | 76.0 W | 12 | 25 | 45 | 2 NM | 18 | 994.2 | 18.4 | 24.4 | 4 | 6.5 | 25 | 8 | 14.5 |
| TRINITY | AMERICAN | 9 | 38.3 N | 69.3 W | 18 | 20 | 45 | 2 NM | 07 | 986.5 | 18.0 | 15.6 | 4 | 10 | 18 | 6 | 16.5 |
| SEALAND MARKET | AMERICAN | 9 | 42.5 N | 67.1 W | 18 | 18 | 45 | 2 NM | 83 | 985.0 | 13.3 | 8.1 | 9 | 24.5 | | | |
| J LOUIS | LIBERIAN | 9 | 38.9 N | 65.3 W | 18 | 17 | 47 | 2 NM | 02 | 1000.0 | 18.2 | 17.7 | 6 | 14.5 | 18 | 7 | 24.5 |
| MOBIL AERO | AMERICAN | 9 | 38.1 N | 71.0 W | 18 | 23 | 50 | .5 NM | 02 | 984.1 | 18.7 | 18.3 | 12 | 29.5 | | | |
| MOBIL FUEL | AMERICAN | 9 | 38.5 N | 71.2 W | 18 | 20 | 50 | 5 NM | 02 | 984.1 | 15.6 | 15.6 | 10 | 41 | | | |
| MOBIL GAS | AMERICAN | 9 | 38.4 N | 72.8 W | 18 | 27 | 44 | 5 NM | 02 | 988.8 | 4.4 | 14.4 | | | 27 | 10 | 11.5 |
| MOBIL POWER | AMERICAN | 9 | 26.7 N | 88.3 W | 00 | 27 | 45 | 10 NM | 01 | 1014.6 | 18.7 | 23.4 | 2 | 6.5 | 27 | 6 | 13 |
| EXXON JAMESTOWN | AMERICAN | 9 | 38.4 N | 71.0 W | 17 | 23 | 50 | .5 NM | 83 | 985.0 | 18.0 | 8.4 | 4 | 14.5 | 28 | 12 | 21 |
| EDGAR M QUEENY | AMERICAN | 9 | 38.5 N | 72.9 W | 19 | 28 | 50 | 2 NM | 26 | 991.2 | 2.2 | 12.2 | 6 | 11.5 | 28 | 12 | 19.5 |
| ADRINQUEN | AMERICAN | 9 | 38.3 N | 72.3 W | 18 | 27 | 44 | 2 NM | 26 | 992.9 | 1.2 | 10.0 | 3 | 24.5 | 18 | 7 | 29.5 |
| TRINITY | AMERICAN | 10 | 37.9 N | 69.0 W | 00 | 25 | 50 | 2 NM | 07 | 998.0 | 14.0 | 20.0 | 4 | 10 | 24 | 6 | 18 |
| SEALAND MARKET | AMERICAN | 10 | 43.1 N | 64.6 W | 00 | 18 | 55 | 2 NM | 84 | 980.7 | 10.5 | 2.8 | 12 | 16.5 | | | |
| J LOUIS | LIBERIAN | 10 | 38.6 N | 65.1 W | 00 | 23 | 50 | 2 NM | 26 | 997.0 | 19.5 | 17.8 | 7 | 24.5 | 20 | 8 | 41 |
| MOBIL GAS | AMERICAN | 10 | 38.9 N | 72.5 W | 00 | 29 | 45 | 2 NM | 07 | 999.9 | 0.9 | 13.3 | | | 28 | 10 | 13 |
| MOBIL AERO | AMERICAN | 10 | 37.5 N | 70.9 W | 06 | 29 | 45 | .5 NM | 25 | 1004.7 | 0.7 | 22.2 | 12 | 24.5 | | | |
| MONTICELLO VICTORY | AMERICAN | 10 | 29.9 N | 79.9 W | 06 | 29 | 45 | 10 NM | 02 | 1022.7 | 11.2 | 26.7 | 5 | 11.5 | | | |
| EXXON JAMESTOWN | AMERICAN | 10 | 38.7 N | 69.9 W | 01 | 25 | 48 | 5 NM | 02 | 999.0 | 3.3 | 10.7 | 4 | 13 | 21 | 12 | 19.5 |
| EASTERN SUN | AMERICAN | 10 | 37.3 N | 67.3 W | 18 | 31 | 55 | 5 NM | 62 | 1005.8 | 11.5 | 19.4 | 6 | 19.5 | 32 | >13 | 44 |
| MONTICELLO VICTORY | AMERICAN | 11 | 37.8 N | 74.3 W | 18 | 34 | 45 | 10 NM | 01 | 1026.1 | 1.2 | 18.7 | 5 | 11.5 | | | |
| EXPORT PATRIOT | AMERICAN | 11 | 48.0 N | 09.0 W | 00 | 29 | 65 | 5 NM | 62 | 1001.5 | 10.5 | 11.7 | 7 | 19.5 | | | |
| EXXON JAMESTOWN | AMERICAN | 11 | 38.5 N | 71.3 W | 01 | 29 | 42 | 5 NM | 70 | 1010.5 | 1.0 | 11.1 | 5 | 10 | 27 | 6 | 16.5 |
| DOCTOR LYKES | AMERICAN | 11 | 45.4 N | 04.1 W | 06 | 27 | 35 | 10 NM | 18 | 998.6 | 11.1 | 12.2 | | | | | |
| DOCTOR LYKES | AMERICAN | 12 | 43.6 N | 03.1 W | 18 | 36 | H 45 | 10 NM | 27 | 1013.9 | 5.6 | 12.2 | | | | | |
| EXXON RANGER | AMERICAN | 13 | 31.0 N | 77.0 W | 18 | 17 | 50 | 2 NM | 21 | 1005.8 | 25.0 | 22.2 | 4 | 8 | | | |
| JOHN LYKES | AMERICAN | 14 | 27.0 N | 71.5 W | 18 | 26 | 48 | 5 NM | 81 | 1009.8 | 22.3 | 25.6 | | | 26 | 8 | 23 |
| AMER CHALLENGER | AMERICAN | 15 | 33.8 N | 63.2 W | 06 | 15 | 47 | 5 NM | 02 | 1014.5 | 19.4 | 20.6 | 3 | 8 | 18 | >13 | 10 |
| SEALAND GALLOWAY | AMERICAN | 15 | 41.8 N | 60.1 W | 12 | 18 | 48 | 2 NM | 02 | 1010.5 | 18.3 | 13.4 | 13 | 36 | | | |
| EXPORT PATRIOT | AMERICAN | 17 | 43.2 N | 69.3 W | 00 | 23 | 50 | 5 NM | 02 | 1017.2 | 0.6 | 4.4 | | | 23 | 8 | 14.5 |
| MOEGH HALLARD | NORWEGIAN | 19 | 43.5 N | 11.4 W | 18 | 28 | H 45 | 5 NM | 81 | 1014.8 | 8.8 | | 10 | 16.5 | | | |
| MOBIL POWER | AMERICAN | 20 | 36.3 N | 72.9 W | 18 | 23 | 45 | 10 NM | 01 | 1005.4 | 19.4 | 21.6 | 5 | 10 | 23 | >13 | 24.5 |
| MOBIL FUEL | AMERICAN | 20 | 34.2 N | 75.7 W | 06 | 14 | 50 | 2 NM | 02 | 1007.1 | 20.0 | 23.3 | 6 | 10 | | | |
| EXPORT LEADER | AMERICAN | 21 | 44.5 N | 33.5 W | 06 | 30 | 45 | 5 NM | 02 | 1022.7 | 8.9 | 15.0 | 5 | 13 | | | |
| DEFIANCE | AMERICAN | 21 | 35.3 N | 61.8 W | 18 | 19 | H 47 | 10 NM | 01 | 1015.0 | 20.6 | 19.4 | XX | 6.5 | 19 | 7 | 19.5 |
| POLYHYMNIA | NORWEGIAN | 22 | 47.1 N | 10.2 W | 00 | 30 | 45 | 5 NM | 01 | 1006.0 | 9.0 | 11.2 | 8 | 11.5 | 29 | 12 | 13 |
| DOCTOR LYKES | AMERICAN | 25 | 25.7 N | 86.5 W | 22 | 23 | 45 | .25 NM | 18 | 1005.0 | 22.1 | 24.4 | 6 | 11.5 | | | |
| MONTICELLO VICTORY | AMERICAN | 25 | 29.0 N | 79.7 W | 18 | 18 | 45 | 10 NM | 02 | 1009.1 | 30.0 | 24.5 | 6 | 14.5 | | | |
| MOBIL ENGINEER | LIBERIAN | 25 | 33.2 N | 73.8 W | 21 | 16 | H 50 | .5 NM | 64 | 1006.0 | 23.5 | 22.0 | 7 | 10 | 16 | 12 | 16.5 |
| SEALAND RESOURCE | AMERICAN | 26 | 37.7 N | 70.5 W | 18 | 21 | 45 | 5 NM | 10 | 996.5 | 17.8 | 20.0 | 8 | 14.5 | 21 | 12 | 23 |
| GOLDEN GATE | AMERICAN | 26 | 38.3 N | 71.4 W | 12 | 18 | 45 | 2 NM | 02 | 988.1 | 21.1 | 13.4 | 11 | 21 | | | |
| EDGAR M QUEENY | AMERICAN | 26 | 34.3 N | 75.4 W | 19 | 23 | 65 | 10 NM | 02 | 1001.4 | 13.4 | 20.0 | 5 | 14.5 | 23 | >13 | 19.5 |
| EXXON WASHINGTON | AMERICAN | 26 | 37.9 N | 72.5 W | 12 | 18 | 45 | 1 NM | 82 | 987.5 | 17.5 | 14.0 | XX | 10 | XX | X | 16.5 |
| MONTICELLO VICTORY | AMERICAN | 26 | 31.9 N | 78.1 W | 06 | 29 | 60 | 2 NM | 02 | 1001.0 | 23.4 | 24.4 | 6 | 28 | | | |
| SNOW CRYSTAL | SWEDISH | 27 | 42.6 N | 18.4 W | 18 | 28 | 44 | 5 NM | 81 | 1009.0 | 13.0 | | 12 | 24.5 | | | |
| SHERMAN | AMERICAN | 27 | 39.6 N | 72.2 W | 12 | 29 | H 46 | 5 NM | 02 | 1001.0 | 0.1 | 2.2 | 4 | 8 | | | |
| EXXON WASHINGTON | AMERICAN | 27 | 36.4 N | 71.7 W | 18 | 23 | 45 | 10 NM | 02 | 1006.6 | 10.0 | 21.2 | XX | 10 | 27 | 13 | 16.5 |
| MONTICELLO VICTORY | AMERICAN | 27 | 36.8 N | 74.6 W | 06 | 31 | 50 | 5 NM | 02 | 1005.8 | | 11.2 | 5 | 16.5 | | | |
| GOLDEN GATE | AMERICAN | 27 | 37.9 N | 71.0 W | 00 | 25 | 45 | 2 NM | 25 | 994.0 | 15.6 | 19.4 | 12 | 21 | | | |
| EDGAR M QUEENY | AMERICAN | 27 | 38.8 N | 73.5 W | 14 | 27 | 50 | 10 NM | 02 | 1004.4 | 0.0 | 7.8 | 5 | 13 | 23 | X | 19.5 |
| AMER EXPLORER | AMERICAN | 29 | 45.9 N | 07.9 W | 18 | 34 | 50 | 10 NM | 03 | 1014.9 | 8.3 | 12.3 | 4 | 6.5 | 34 | >13 | 11.5 |
| NORMACSUN | AMERICAN | 30 | 49.6 N | 05.6 W | 00 | 31 | 50 | 5 NM | 02 | 1009.1 | 5.5 | 9.0 | 8 | 16.5 | | | |
| GREAT LAKES VESSELS | | | | | | | | | | | | | | | | | |
| CHAMPLAIN | AMERICAN | 3 | 44.1 N | 82.7 W | 00 | 21 | M 43 | 5 NM | 02 | | - 9.0 | 3.0 | | | | | |
| NORTHWIND | AMERICAN | 9 | 41.8 N | 82.4 W | 21 | 31 | M 54 | 5 NM | 03 | | -10.0 | 0.0 | | | | | |
| ARTHUR M ANDERSON | AMERICAN | 9 | 42.6 N | 87.7 W | 00 | 30 | M 47 | 10 NM | 02 | | -15.0 | 2.0 | | | | | |
| NORTHWIND | AMERICAN | 10 | 41.8 N | 82.5 W | 00 | 30 | M 46 | 2 NM | 02 | | -10.0 | 0.0 | | | | | |
| ARTHUR M ANDERSON | AMERICAN | 10 | 45.9 N | 84.2 W | 00 | 31 | M 47 | 1 NM | 73 | | -14.0 | 2.0 | | | | | |
| NORTHWIND | AMERICAN | 26 | 41.8 N | 82.4 W | 12 | 22 | M 50 | < 5n YD | 75 | | | 0.0 | | | | | |
| J BURTON AYERS | AMERICAN | 26 | 41.8 N | 82.6 W | 12 | 21 | M 50 | < 5n YD | 75 | | -22.0 | 2.0 | | | | | |
| ARTHUR M ANDERSON | AMERICAN | 26 | 46.3 N | 84.2 W | 18 | 26 | M 50 | 5 NM | 02 | | -16.0 | 3.0 | | | | | |
| LEON FRASER | AMERICAN | 26 | 46.1 N | 84.0 W | 18 | 01 | M 45 | 5n YD | 75 | | -11.0 | 5.0 | | | | | |
| NORTHWIND | AMERICAN | 27 | 41.9 N | 82.3 W | 03 | 26 | M 49 | < 5n YD | 75 | | -10.0 | 0.0 | | | | | |
| J BURTON AYERS | AMERICAN | 28 | 41.8 N | 82.6 W | 00 | 27 | M 47 | < 5n YD | 75 | | -27.0 | 0.0 | | | | | |
| ENVIRONMENTAL BUOYS | | | | | | | | | | | | | | | | | |
| 41002 | AMERICAN | 9 | 32.3 N | 75.3 W | 15 | 27 | M 46 | | | 1006.5 | 16.1 | 21.6 | 8 | 18 | | | |
| 41002 | AMERICAN | 13 | 32.3 N | 75.3 W | 21 | 17 | M 42 | | | 1005.3 | 20.7 | 23.8 | 7 | 13 | | | |
| 44004 | AMERICAN | 9 | 39.0 N | 70.0 W | 21 | 24 | M 43 | | | 992.8 | 6.3 | 9.4 | 10 | 23 | | | |
| 44004 | AMERICAN | 10 | 39.0 N | 70.0 W | 03 | 25 | M 42 | | | 1004.0 | 1.5 | 9.9 | 11 | 24.5 | | | |
| NORTH ATLANTIC OCEAN | | FEB. | | | | | | | | | | | | | | | |
| NORMACSUN | AMERICAN | 2 | 44.7 N | 33.6 W | 18 | 19 | 42 | 2 NM | 80 | 1007.8 | 15.0 | 13.4 | 5 | 8 | 19 | 7 | 16.5 |
| ALMERIA LYKES | AMERICAN | 2 | 48.7 N | 08.7 W | 00 | 29 | 55 | 5 NM | 02 | 1015.2 | 9.8 | 8.8 | 6 | 11.5 | 29 | 11 | 18 |
| NORMACSUN | AMERICAN | 3 | 44.3 N | 34.8 W | 00 | 25 | 45 | 5 NM | 80 | 1013.9 | 12.7 | 13.4 | 6 | 10 | | | |
| NORMACSUN | AMERICAN | 5 | 44.9 N | 46.0 W | 00 | 26 | 45 | 10 NM | 02 | 1017.3 | 2.7 | 7.8 | 6 | 10 | | | |
| YOUNG AMERICA | AMERICAN | 6 | 39.5 N | 65.4 W | 21 | 09 | 65 | 5 NM | 02 | 1001.8 | 13.4 | 13.4 | 5 | 14.5 | 09 | 6 | 19.5 |
| MOBIL POWER | AMERICAN | 6 | 37.8 N | 71.0 W | 18 | 28 | 48 | 10 NM | 02 | 998.3 | 12.3 | 19.5 | 8 | 10 | XX | | 11.5 |
| ARECIBO | AMERICAN | 7 | 37.5 N | 72.2 W | 00 | 33 | 45 | 1 NM | 28 | 1013.5 | 5.6 | 13.4 | | | 23 | 12 | 10 |
| SEALAND RESOURCE | AMERICAN | 7 | 43.2 N | 37.8 W | 18 | 29 | 50 | 5 NM | 15 | 1007.0 | 10.0 | 12.8 | 6 | 16.5 | 29 | 9 | 24.5 |
| YOUNG AMERICA | AMERICAN | 7 | 39.5 N | 65.2 W | 00 | 09 | 65 | 5 NM | 02 | 1000.3 | 13.4 | 15.4 | 5 | 14.5 | 09 | < 6 | 24.5 |
| SANTA CRUZ | AMERICAN | 7 | 32.3 N | 72.9 W | 12 | 27 | 50 | 5 NM | 02 | 1009.8 | 10.0 | 19.4 | 5 | 11.5 | 31 | 10 | 16.5 |
| NORMACSUN | AMERICAN | 7 | 42.9 N | 55.0 W | 18 | 08 | 45 | .25 NM | 72 | 996.3 | 3.3 | 1.6 | 10 | 23 | | | |
| YOUNG AMERICA | AMERICAN | 8 | 38.2 N | 65.5 W | 00 | 26 | 55 | 10 NM | 61 | 994.9 | 11.7 | 18.0 | 5 | 14.5 | 26 | 8 | 29.5 |
| NORMACSUN | AMERICAN | 8 | 40.8 N | 38.2 W | 12 | 35 | 50 | 5 NM | 02 | 1011.2 | 1.5 | 4.5 | 6 | 16.5 | | | |
| SEALAND GALLOWAY | AMERICAN | 9 | 41.5 N | 51.2 W | 12 | 30 | 45 | 5 NM | 02 | 999.6 | 8.7 | 17.3 | 12 | 24.5 | | | |
| TREIN MAERSK | DANISH | 9 | 37.4 N | 50.4 W | 00 | 27 | 45 | 2 NM | 81 | 1000.3 | 15.0 | | 8 | 19.5 | | | |
| MONTICELLO VICTORY | AMERICAN | 10 | 29.1 N | 79.5 W | 18 | 31 | 45 | 10 NM | 02 | 1011.9 | 16.2 | 26.2 | 5 | 8 | | | |
| MONTICELLO VICTORY | AMERICAN | 11 | 34.1 N | 75.9 W | 18 | 36 | 45 | 10 NM | 02 | 1016.6 | 9.6 | 19.4 | 5 | 10 | | | |

| Vessel | Nationality | Date | Position of Ship | | Time GMT | Wind | | Visibility n. mi. | Present Weather code | Pressure mb | Temperature °C | | Sea Waves* | | Swell Waves | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Lat. deg. | Long. deg. | | Dir. 10° | Speed kt. | | | | Air | Sea | Period sec. | Height ft | Dir. 10° | Period sec. | Height ft |
| NORTH ATLANTIC OCEAN | | FEB. | | | | | | | | | | | | | | | |
| SEALAND PRODUCER | AMERICAN | 12 | 29.8 N | 92.8 W | 12 | 23 | 38 | 9 NM | 07 | 988.3 | 17.8 | 17.8 | | | | | |
| MORMACSEA | AMERICAN | 12 | 30.5 N | 80.7 W | 12 | 30 | 50 | 5 NM | 25 | 999.3 | 13.6 | 21.1 | 12 | 29.5 | | | |
| EXPORT LEADER | AMERICAN | 12 | 38.9 N | 57.4 W | 18 | 32 | 60 | 5 NM | 02 | 976.0 | 11.2 | 20.0 | 8 | 24.5 | 36 | 8 | 24.5 |
| SEALAND PRODUCER | AMERICAN | 13 | 29.0 N | 94.8 W | 00 | 29 | 55 | 10 NM | 18 | 995.4 | 15.6 | 18.9 | 8 | 13 | 24 | 12 | 29.5 |
| MORMACSEA | AMERICAN | 13 | 32.5 N | 84.3 W | 12 | 30 | 45 | 5 NM | 29 | 1006.4 | 13.9 | 20.0 | 12 | 19.5 | | | |
| LIGHTNING | AMERICAN | 13 | 36.7 N | 59.5 W | 18 | 31 | 45 | 5 NM | 02 | 997.0 | 10.6 | 20.0 | 13 | 19.5 | 34 | >13 | 24.5 |
| EXPORT LEADER | AMERICAN | 13 | 36.2 N | 57.0 W | 06 | 32 | 60 | 5 NM | 02 | 970.5 | 10.0 | 13.0 | 10 | 26 | 36 | 10 | 24.5 |
| MORMACSEA | AMERICAN | 14 | 37.5 N | 70.4 W | 12 | 04 | 30 | 2 NM | 01 | 992.9 | 13.3 | 21.1 | 7 | 14.5 | | | |
| LIGHTNING | AMERICAN | 14 | 36.2 N | 54.8 W | 00 | 31 | 55 | 5 NM | 02 | 994.0 | 12.2 | 18.4 | 20 | 24.5 | 32 | >13 | 29.5 |
| NORDEN HALLARD | NORWEGIAN | 14 | 36.2 N | 35.6 W | 18 | 23 M | 65 | 2 NM | 63 | 976.5 | 10.5 | 17.0 | | | 24 | 12 | 23 |
| EXPORT PATRIOT | AMERICAN | 14 | 48.3 N | 48.5 W | 00 | 08 | 45 | 10 NM | 02 | 993.9 | 4.5 | 5.5 | 3 | 10 | 07 | 6 | 19.5 |
| EXPORT LEADER | AMERICAN | 14 | 39.8 N | 57.2 W | 00 | 31 | 60 | 5 NM | 02 | 988.8 | 10.0 | 13.6 | 10 | 24.5 | 36 | 10 | 26 |
| SEALAND MARKET | AMERICAN | 14 | 36.8 N | 34.0 W | 18 | 21 | 45 | 5 NM | 25 | 976.6 | 10.2 | 13.7 | 5 | 11.5 | 23 | 7 | 23 |
| NORDEN HALLARD | NORWEGIAN | 15 | 36.0 N | 35.8 W | 00 | 24 M | 45 | 5 NM | 01 | 985.5 | 17.0 | 17.0 | 5 | 6.5 | 24 | 12 | 19.5 |
| LIGHTNING | AMERICAN | 15 | 36.3 N | 48.5 W | 00 | 32 | 42 | 10 NM | 01 | 995.0 | 14.0 | 18.4 | 15 | 19.5 | 31 | >13 | 29.5 |
| EXPORT FREEDOM | AMERICAN | 15 | 38.5 N | 32.3 W | 06 | 22 | 45 | 10 NM | 02 | 980.0 | | 13.6 | 6 | 16.5 | 24 | 7 | 26 |
| SEALAND MARKET | AMERICAN | 15 | 37.0 N | 35.2 W | 00 | 23 | 48 | 10 NM | 02 | 981.0 | 17.2 | 15.6 | 5 | 13 | 23 | 6 | 24.5 |
| AMER EXPLORER | AMERICAN | 16 | 38.5 N | 26.0 W | 18 | 20 | 50 | 5 NM | 02 | 988.6 | 16.4 | 15.7 | | | 20 | >13 | 16.5 |
| NORDEN HALLARD | NORWEGIAN | 16 | 34.0 N | 39.1 W | 06 | 27 M | 45 | 5 NM | 02 | 988.5 | 17.8 | 18.0 | 4 | 5 | 27 | 12 | 23 |
| EXPORT FREEDOM | AMERICAN | 16 | 41.0 N | 39.8 W | 18 | 28 | 45 | 5 NM | 82 | 981.0 | 10.0 | 16.2 | 6 | 16.5 | 27 | 7 | 29.5 |
| SEALAND MARKET | AMERICAN | 16 | 38.6 N | 30.0 W | 12 | 32 | 42 | 10 NM | 25 | 998.0 | 9.4 | 17.2 | 5 | 10 | XX | | 19.5 |
| EXPORT FREEDOM | AMERICAN | 17 | 40.2 N | 43.0 W | 12 | 31 | 50 | 2 NM | 01 | 992.0 | 10.0 | 16.7 | | | 31 | 12 | 32.5 |
| AMER EXPLORER | AMERICAN | 18 | 36.9 N | 31.3 W | 18 | 30 | 45 | 10 NM | 01 | 999.8 | 15.0 | 16.2 | | | 30 | >13 | 29.5 |
| AMER EXPLORER | AMERICAN | 19 | 36.6 N | 32.6 W | 00 | 30 | 45 | 10 NM | 02 | 1004.4 | 13.2 | 16.1 | | | | | |
| STAGHOUND | AMERICAN | 19 | 48.7 N | 41.1 W | 18 | 27 | 48 | 5 NM | 15 | 984.5 | 7.8 | 13.4 | 4 | 10 | 27 | 8 | 16.5 |
| DOCTOR LYKES | AMERICAN | 19 | 39.6 N | 54.2 W | 18 | 13 | 42 | 5 NM | 51 | 998.3 | 12.8 | 15.0 | 5 | 8 | | | |
| SAMUEL CHASE | AMERICAN | 19 | 44.7 N | 37.6 W | 12 | 27 | 55 | 10 NM | 81 | 992.6 | 7.7 | 14.4 | 6 | 24.5 | 27 | 12 | 39 |
| STAGHOUND | AMERICAN | 20 | 47.9 N | 42.6 W | 00 | 27 | 45 | 5 NM | 15 | 999.2 | 3.4 | 7.9 | 4 | 10 | 27 | 8 | 16.5 |
| DOCTOR LYKES | AMERICAN | 20 | 39.5 N | 51.9 W | 00 | 09 | 45 | 10 NM | 02 | 995.5 | 12.2 | 15.6 | 6 | 10 | | | |
| AMER LEGEND | AMERICAN | 21 | 48.4 N | 25.4 W | 18 | 07 M | 43 | 5 NM | 03 | 994.0 | 9.4 | 11.1 | 5 | 14.5 | 07 | >13 | 19.5 |
| AMER COURIER | AMERICAN | 21 | 43.0 N | 48.3 W | 12 | 32 | 45 | 10 NM | 02 | 1012.5 | 4.5 | 3.5 | 10 | 16.5 | 32 | >13 | 16.5 |
| MEONIA | DANISH | 21 | 40.1 N | 37.2 W | 12 | 28 M | 63 | 2 NM | 82 | 985.0 | 11.6 | | 12 | 32.5 | | | |
| ADM W M CALLAGHAN | AMERICAN | 21 | 37.8 N | 31.7 W | 18 | 27 | 65 | 1 NM | 18 | 988.9 | 10.2 | 12.8 | | | 27 | 10 | 29.5 |
| OLIVIA MAERSK | DANISH | 21 | 36.2 N | 45.2 W | 12 | 30 M | 43 | 10 NM | 01 | 1010.2 | 13.2 | 14.0 | 7 | 10 | 30 | 12 | 16.5 |
| SNOW LAND | SWEDISH | 21 | 40.2 N | 20.5 W | 12 | 20 | 45 | .5 NM | 63 | 990.5 | 16.0 | 13.8 | | 24.5 | | | |
| CRESCO | NORWEGIAN | 21 | 37.3 N | 33.2 W | 18 | 27 | 50 | 2 NM | 10 | 1009.0 | 15.0 | 16.0 | 10 | 29.5 | | | |
| DOCTOR LYKES | AMERICAN | 21 | 40.7 N | 34.4 W | 18 | 29 | 70 | 1 NM | 81 | 983.0 | 10.6 | 15.6 | 10 | 24.5 | 29 | 12 | 41 |
| CARDIGAN | BRITISH | 21 | 37.2 N | 35.9 W | 18 | 28 | 50 | 2 NM | 07 | 984.2 | 15.5 | 16.7 | 4 | 10 | 27 | 9 | 26 |
| LASH PACIFICO | AMERICAN | 21 | 33.0 N | 26.9 W | 12 | 22 | 46 | 5 NM | 02 | 1005.4 | 18.6 | 17.3 | 3 | 6.5 | 24 | 8 | 19 |
| SEALAND GALLOWAY | AMERICAN | 21 | 41.1 N | 34.5 W | 12 | 28 | 50 | 2 NM | 82 | 976.1 | 11.7 | 12.7 | 8 | 41 | | | |
| ZIM NEW YORK | GERMAN | 21 | 40.0 N | 37.3 W | 12 | 27 | 56 | 2 NM | 25 | 983.9 | 10.2 | 16.0 | 9 | 32.5 | | | |
| SAMUEL CHASE | AMERICAN | 21 | 44.2 N | 46.2 W | 00 | 32 | 64 | 2 NM | 21 | 981.4 | 7.3 | 14.4 | 5 | 19.5 | 32 | 9 | 41 |
| MEONIA | DANISH | 22 | 38.8 N | 38.4 W | 00 | 28 M | 60 | 2 NM | 82 | 1005.0 | 12.0 | 15.0 | 10 | 32.5 | | | |
| ADM W M CALLAGHAN | AMERICAN | 22 | 37.9 N | 29.3 W | 00 | 27 | 50 | 2 NM | 82 | 984.0 | 11.7 | 12.8 | 8 | 29.5 | | | |
| AGUADILLA | AMERICAN | 22 | 31.7 N | 73.4 W | 18 | 30 | 45 | 10 NM | 01 | 1008.0 | 10.6 | 23.3 | 6 | 19.5 | 30 | 7 | 24.5 |
| CARDIGAN | BRITISH | 22 | 37.2 N | 36.5 W | 00 | 28 | 48 | 2 NM | 03 | 1001.5 | 13.8 | 18.3 | 3 | 6.5 | 28 | 8 | 24.5 |
| SEALAND GALLOWAY | AMERICAN | 22 | 40.2 N | 36.6 W | 00 | 29 | 56 | 1 NM | 07 | 992.2 | 11.7 | 13.4 | 12 | 41 | | | |
| CHERRY VALLEY | AMERICAN | 22 | 41.4 N | 09.6 W | 00 | 18 | 45 | 5 NM | 02 | 1005.8 | 13.9 | 12.2 | 6 | 6.5 | 18 | 7 | 8 |
| GREEN HARBOUR | AMERICAN | 22 | 34.5 N | 65.8 W | 18 | 27 | 45 | 5 NM | 92 | 981.5 | 15.6 | 18.4 | 10 | 16.5 | | | |
| DOCTOR LYKES | AMERICAN | 22 | 40.8 N | 33.9 W | 00 | 31 | 66 | 1 NM | 80 | 993.0 | 11.7 | 15.6 | 10 | 29.5 | 30 | 12 | 41 |
| CRESCO | NORWEGIAN | 22 | 37.3 N | 31.6 W | 00 | 27 | 45 | 2 NM | 10 | 1009.0 | 15.0 | 16.0 | 10 | 29.5 | | | |
| EXXON JAMESTOWN | AMERICAN | 22 | 29.6 N | 80.3 W | 13 | 31 | 45 | 10 NM | 02 | 1021.0 | 4.5 | 21.2 | 3 | 8 | 31 | < 6 | 14.5 |
| LASH PACIFICO | AMERICAN | 22 | 32.1 N | 31.9 W | 06 | 34 | 47 | 5 NM | 02 | 1008.1 | 16.1 | 18.4 | 5 | 11.5 | 32 | 12 | 32.5 |
| MORMACSKY | AMERICAN | 22 | 34.5 N | 74.2 W | 12 | 34 | 48 | 1 NM | 05 | 1005.8 | 7.0 | 19.5 | 6 | 13 | 32 | L | 18 |
| BRAZOS | AMERICAN | 22 | 30.3 N | 73.5 W | 18 | 27 | 45 | 5 NM | 07 | 1009.3 | 13.0 | 21.1 | 5 | 10 | 27 | 8 | 19.5 |
| ZIM NEW YORK | GERMAN | 22 | 40.7 N | 42.2 W | 18 | 27 | 64 | .5 NM | | 999.8 | 12.5 | 16.3 | 9 | 19.5 | | | |
| MEONIA | DANISH | 23 | 32.5 N | 68.5 W | 12 | 24 M | 48 | 2 NM | 25 | 1000.5 | 21.0 | | 12 | 16.5 | | | |
| MORMACSKY | AMERICAN | 23 | 35.0 N | 74.5 W | 00 | 34 | 45 | 1 NM | 09 | 1013.0 | 1.1 | 22.2 | 5 | 13 | 32 | 8 | 18 |
| AMER COURIER | AMERICAN | 23 | 41.2 N | 39.4 W | 00 | 17 | 60 | 5 NM | 02 | 998.1 | 12.3 | 15.5 | | | 17 | < 6 | 10 |
| AMER LEGEND | AMERICAN | 23 | 45.2 N | 45.4 W | 18 | 07 M | 80 | 2 NM | 82 | 951.0 | 6.7 | 5.5 | 6 | 23 | | | |
| AMER ARCHER | AMERICAN | 23 | 45.4 N | 46.1 W | 18 | 07 | 50 | 5 NM | 23 | 955.5 | 5.0 | 12.2 | 8 | 19.5 | 07 | 8 | 26 |
| AGUADILLA | AMERICAN | 23 | 32.1 N | 73.9 W | 00 | 31 | 40 | 1 NM | 63 | 1012.5 | 6.1 | 21.2 | 7 | 32.5 | | | |
| OLIVIA MAERSK | DANISH | 23 | 38.1 N | 53.4 W | 06 | 34 M | 58 | 2 NM | 02 | 980.4 | 15.4 | 16.0 | 7 | 11.5 | 26 | 12 | 23 |
| BRAZOS | AMERICAN | 23 | 30.3 N | 73.8 W | 00 | 24 | 48 | 5 NM | 07 | 1011.3 | 15.0 | 21.2 | 5 | 13 | 24 | 8 | 24.5 |
| ZIM NEW YORK | GERMAN | 23 | 43.1 N | 49.5 W | 18 | 29 | 47 | 2 NM | 02 | 986.9 | 2.8 | 5.0 | 6 | 13 | | | |
| SEALAND GALLOWAY | AMERICAN | 23 | 37.2 N | 32.3 W | 18 | 28 | 45 | 10 NM | 02 | 989.0 | 16.8 | 14.5 | 6 | 26 | | | |
| EVERGREEN | AMERICAN | 23 | 32.1 N | 64.5 W | 00 | 26 M | 46 | 2 NM | 13 | 1011.3 | 15.0 | 19.1 | 8 | 11.5 | | | |
| GREEN HARBOUR | AMERICAN | 23 | 34.7 N | 67.1 W | 00 | 25 | 35 | 5 NM | 19 | 985.0 | 10.0 | 18.4 | 10 | 11.5 | 25 | 7 | 26 |
| LASH PACIFICO | AMERICAN | 23 | 32.9 N | 43.9 W | 18 | 23 | 45 | 2 NM | 23 | 1000.7 | 18.9 | 18.4 | 4 | 6.5 | 23 | 8 | 19.5 |
| OLIVIA MAERSK | DANISH | 24 | 36.0 N | 55.0 W | 00 | 26 M | 54 | 5 NM | 81 | 997.6 | 14.0 | 16.0 | 6 | 11.5 | 26 | 13 | 24.5 |
| AMER COURIER | AMERICAN | 24 | 43.5 N | 23.8 W | 18 | 30 | 45 | 10 NM | 03 | 977.0 | 14.5 | 14.0 | 5 | 10 | 30 | 8 | 16.5 |
| AMER LEGACY | AMERICAN | 24 | 46.4 N | 26.0 W | 12 | 25 | 45 | 5 NM | 27 | 988.2 | 13.3 | 12.2 | 5 | 11.5 | 20 | 8 | 16.5 |
| AMER LEGEND | AMERICAN | 24 | 44.8 N | 47.3 W | 00 | 32 M | 45 | 5 NM | 80 | 989.0 | 2.8 | 5.5 | 6 | 19.5 | | | |
| AMER COURIER | AMERICAN | 25 | 46.6 N | 10.0 W | 18 | 29 | 45 | 5 NM | 03 | 969.0 | 12.3 | 12.3 | 6 | 19.5 | 30 | 10 | 24.5 |
| AMER CHALLENGER | AMERICAN | 25 | 44.2 N | 15.0 W | 18 | 25 | 45 | 10 NM | 38 | 978.0 | 12.2 | 12.2 | | | 25 | >13 | 13 |
| BAJKA | NORWEGIAN | 25 | 42.5 N | 11.0 W | 12 | 24 | 48 | > 25 NM | 02 | 991.2 | 14.0 | 14.0 | 5 | 16.5 | 25 | 10 | 19.5 |
| LASH PACIFICO | AMERICAN | 25 | 32.4 N | 52.6 W | 06 | 27 | 45 | 10 NM | 01 | 1009.5 | 17.7 | 18.4 | | | 27 | 8 | 16.5 |
| AMER CHALLENGER | AMERICAN | 26 | 45.3 N | 13.0 W | 00 | 24 | 45 | 5 NM | 07 | 979.5 | 12.3 | 12.3 | 7 | 13 | 26 | >13 | 13 |
| BAJKA | NORWEGIAN | 26 | 42.1 N | 12.1 W | 00 | 24 | 50 | 10 NM | 02 | 992.5 | 15.0 | | 6 | 19.5 | 25 | 12 | 26 |
| BAJKA | NORWEGIAN | 27 | 39.2 N | 17.9 W | 12 | 26 | 45 | 10 NM | 01 | 1005.5 | 10.1 | 12.0 | 5 | 16.5 | 27 | 12 | 26 |
| BAJKA | NORWEGIAN | 28 | 37.8 N | 21.0 W | 06 | 24 | 50 | 1 NM | 62 | 1005.5 | 13.2 | | 6 | 16.5 | 26 | 12 | 26 |
| TILLIE LYKES | AMERICAN | 28 | 40.1 N | 17.8 W | 12 | 28 | 50 | 10 NM | 82 | 996.0 | 12.0 | 13.3 | 12 | 18 | | | |
| GREAT LAKES VESSELS | | | | | | | | | | | | | | | | | |
| ARTHUR M ANDERSON | AMERICAN | 5 | 45.1 N | 86.9 W | 12 | 32 M | 45 | 10 NM | 00 | | -10.0 | 2.0 | | 5 | | | |
| ENVIRONMENTAL BUOYS | | | | | | | | | | | | | | | | | |
| 44002 | AMERICAN | 6 | 40.1 N | 73.0 W | 21 | 06 | M 43 | | | 990.6 | 2.2 | 5.7 | | | | | |
| 44004 | AMERICAN | 6 | 39.0 N | 70.0 W | 15 | 09 | M 42 | | | 1004.2 | 8.4 | 8.3 | 7 | 13 | | | |

\+ Direction for sea waves same as wind direction
X Direction or period of waves indeterminate
M Measured wind

NOTE: The observations are selected from those with winds $\geq$ 35 kn or waves $\geq$ 25 ft from May through August ($\geq$ 41 kn or $\geq$ 33 ft, September through April). In cases where a ship reported more than one observation a day with such values, the one with the highest wind speed was selected.

# Selected Gale and Wave Observations, North Pacific

## January and February 1978

| Vessel | Nationality | Date | Position of Ship | | Time GMT | Wind | | Visibility n. mi. | Present Weather code | Pressure mb | Temperature °C | | Sea Waves* | | Swell Waves | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Lat. deg | Long. deg | | Dir. 10° | Speed kt | | | | Air | Sea | Period sec | Height ft | Dir. 10° | Period sec. | Height ft. |
| NORTH PACIFIC OCEAN | | JAN. | | | | | | | | | | | | | | | |
| ORIENTAL SOVEREIGN | LIBERIAN | 1 | 43.0 N | 168.1 E | 12 | 13 M | 45 | 1 NM | 65 | 1002.0 | 3.0 | 6.0 | | | 13 | < 6 | 13 |
| ASIA BRAVERY | LIBERIAN | 2 | 40.2 N | 161.8 E | 12 | 29 M | 42 | 2 NM | | 1006.0 | 9.0 | 13.0 | | | | | |
| VAN CONQUEROR | LIBERIAN | 2 | 37.0 N | 168.0 E | 06 | 22 M | 45 | 2 NM | 61 | 1004.0 | 15.0 | 15.0 | | | | | |
| OVERSEAS NEW YORK | AMERICAN | 2 | 44.8 N | 130.7 W | 00 | 09 | 42 | 5 NM | 03 | 1009.1 | 10.0 | 7.2 | 3 | 10 | 11 | 7 | 18 |
| MAINE | AMERICAN | 3 | 48.7 N | 163.2 W | 21 | 24 | 42 | 5 NM | 00 | 980.4 | 5.4 | 3.9 | 6 | 6.3 | 24 | 8 | 18 |
| ORIENTAL SOVEREIGN | LIBERIAN | 3 | 43.9 N | 179.0 E | 00 | 27 M | 48 | > 25 NM | 02 | 1001.5 | 7.0 | 9.0 | 10 | 19.5 | | | |
| PRES FILLMORE | AMERICAN | 3 | 19.3 N | 120.8 E | 03 | 09 | 45 | 10 NM | 60 | 1020.7 | 25.6 | 26.2 | 7 | 10 | 02 | 8 | 10 |
| PRES JEFFERSON | AMERICAN | 3 | 50.3 N | 164.0 E | 12 | 27 | 30 | 9 NM | 85 | 990.0 | - 2.8 | 2.2 | 8 | 18 | 28 | 6 | 24.5 |
| ASIA BRAVERY | LIBERIAN | 4 | 43.9 N | 175.0 E | 12 | 07 M | 42 | 200 YD | 71 | 973.5 | 3.0 | 11.0 | | | | | |
| VAN CONQUEROR | LIBERIAN | 4 | 40.1 N | 174.1 W | 18 | 23 M | 49 | 2 NM | 03 | 980.0 | 10.0 | 15.0 | | | | | |
| VANGUARD | LIBERIAN | 4 | 38.1 N | 177.5 W | 00 | 27 M | 00 | 1 NM | 61 | 1004.0 | 13.0 | 17.0 | | | | | |
| MAINE | AMERICAN | 4 | 48.9 N | 154.4 W | 00 | 24 | 50 | 5 NM | 03 | 982.2 | 5.5 | 3.9 | 4 | 8 | 24 | 8 | 19.5 |
| PRES JEFFERSON | AMERICAN | 4 | 45.3 N | 154.0 E | 18 | 27 | 45 | 5 NM | 01 | 998.8 | - 3.3 | - 0.6 | 8 | 19.5 | 28 | 7 | 29.5 |
| SONGKHLA | DANISH | 5 | 46.2 N | 166.7 W | 06 | 10 M | 45 | 2 NM | 61 | 972.0 | 6.2 | | 10 | 23 | | | |
| VAN CONQUEROR | LIBERIAN | 5 | 40.6 N | 171.2 W | 03 | 25 M | 70 | 2 NM | 03 | 974.0 | 7.0 | 15.0 | | | | | |
| VANGUARD | LIBERIAN | 5 | 37.0 N | 164.2 W | 18 | 27 M | 45 | 1 NM | 80 | 988.0 | 11.0 | 16.0 | | | | | |
| MICHIGAN | AMERICAN | 5 | 31.0 N | 172.0 W | 18 | 29 | 45 | 10 NM | 01 | 1013.2 | 15.6 | 15.6 | 4 | 8 | 30 | 9 | 11.5 |
| ORIENTAL SOVEREIGN | LIBERIAN | 5 | 45.1 N | 166.5 W | 00 | 11 M | 47 | 2 NM | 25 | 985.0 | 6.0 | 8.0 | 10 | 14.5 | | | |
| SEATRAIN PRINCETON | GERMAN | 5 | 36.9 N | 132.2 W | 00 | 25 | 37 | 1 NM | 00 | 998.5 | 14.6 | 16.0 | 5 | 10 | XX | X | 16.5 |
| SEATRAIN LEXINGTON | GERMAN | 5 | 35.8 N | 163.5 W | 18 | 27 | 45 | 5 NM | 01 | 993.5 | 12.4 | 14.0 | 12 | 18 | | | |
| STREAM RUDDER | LIBERIAN | 5 | 36.8 N | 144.1 W | 18 | 27 M | 00 | 1 NM | 18 | 990.0 | 10.5 | 13.5 | 8 | 39 | 27 | 11 | 65.5 |
| VAN CONQUEROR | LIBERIAN | 6 | 41.4 N | 174.7 W | 00 | 30 M | 50 | 2 NM | 80 | 968.0 | 7.0 | 13.0 | | | | | |
| VANGUARD | LIBERIAN | 6 | 37.3 N | 162.6 W | 00 | 17 M | 00 | .5 NM | 10 | 984.0 | 12.0 | 16.0 | | | | | |
| YAMASHIN MARU | JAPANESE | 6 | 39.1 N | 141.0 W | 15 | 18 M | 41 | .25 NM | 65 | 988.5 | 13.0 | 12.0 | 4 | 8 | 18 | 8 | 13 |
| JAPAN CACBO | LIBERIAN | 6 | 33.0 N | 143.0 E | 00 | 29 | 42 | 10 NM | 02 | 1015.0 | 10.0 | 15.0 | | | | | |
| ORIENTAL SOVEREIGN | LIBERIAN | 6 | 45.1 N | 163.0 W | 00 | 09 M | 27 | 10 NM | 01 | 969.0 | 8.0 | 8.0 | 8 | 10 | 23 | >13 | 32.5 |
| STREAM RUDDER | LIBERIAN | 6 | 36.5 N | 154.8 W | 06 | 28 M | 70 | 1 NM | 07 | 993.0 | 10.0 | 14.0 | 10 | 32.5 | 28 | >13 | 65.5 |
| PACIFIC SAGA | LIBERIAN | 6 | 31.2 N | 161.1 W | 06 | 29 | 50 | > 25 NM | 13 | 1004.2 | 16.0 | 18.0 | | | 28 | 9 | 32.5 |
| OVERSEAS OHIO | AMERICAN | 7 | 50.0 N | 137.4 W | 12 | 12 | 65 | 1 NM | 04 | 982.1 | 3.5 | 4.0 | 7 | 29.5 | | | |
| PACIFIC SAGA | LIBERIAN | 7 | 30.5 N | 156.8 W | 00 | 28 | 37 | > 25 NM | 01 | 1002.0 | 18.5 | 18.0 | 8 | 32.5 | 23 | >13 | 32.5 |
| SEATRAIN PRINCETON | GERMAN | 7 | 35.1 N | 145.9 W | 18 | 19 | 44 | 1 NM | 81 | 984.8 | 10.8 | 15.2 | 7 | 6.5 | XX | X | 26 |
| STREAM RUDDER | LIBERIAN | 7 | 36.8 N | 154.8 W | 00 | 30 M | 36 | 9 NM | 03 | 984.5 | 11.0 | 14.0 | 10 | 29.5 | 29 | >13 | 47.9 |
| OVERSEAS NATALIE | AMERICAN | 7 | 52.7 N | 138.1 W | 12 | 09 | 50 | 5 NM | 02 | 993.9 | 3.3 | 5.5 | | | 09 | 8 | 19.5 |
| SEATRAIN LEXINGTON | GERMAN | 7 | 35.7 N | 144.6 W | 18 | 19 | 42 | 5 NM | 02 | 987.3 | 16.4 | 16.5 | 8 | 11.5 | | | |
| GALVESTON | LIBERIAN | 7 | 53.6 N | 138.2 W | 18 | 09 | 45 | 1 NM | 65 | 986.8 | 0.6 | 3.0 | 10 | 10 | 09 | 12 | 13 |
| MOBIL MERICIAN | AMERICAN | 7 | 55.8 N | 161.6 W | 18 | 08 | 45 | 10 NM | 26 | 990.3 | 1.3 | 4.5 | 6 | 8 | 09 | 8 | 18 |
| KOREA PHOENIX | SINGAPORE | 7 | 52.0 N | 161.5 W | 17 | 07 M | 41 | 1 NM | 50 | 988.5 | 3.0 | | 7 | 11.5 | | | |
| ARCO ANCHORAGE | AMERICAN | 8 | 56.9 N | 161.9 W | 12 | 11 | 45 | 1 NM | 61 | 987.0 | 7.0 | 2.3 | | | 11 | 7 | 23 |
| PACIFIC SAGA | LIBERIAN | 8 | 28.8 N | 150.9 W | 00 | 27 | 37 | 10 NM | 01 | 998.5 | 22.5 | 20.0 | 8 | 16.5 | 27 | >13 | 32.5 |
| SEVEN OCEAN | JAPANESE | 8 | 39.7 N | 178.2 E | 18 | 29 M | 47 | .25 NM | | 990.1 | 9.0 | 14.0 | 6 | 9 | | | |
| SEATRAIN PRINCETON | GERMAN | 8 | 35.1 N | 145.9 W | 00 | 25 | 44 | 2 NM | 25 | 983.5 | 14.0 | 15.0 | 7 | 6.5 | XX | X | 26 |
| MOBIL MERICIAN | AMERICAN | 8 | 55.0 N | 161.1 W | 00 | 09 | 47 | 2 NM | 22 | 988.1 | 2.2 | 4.5 | | | 07 | 11 | 19.5 |
| MARIPOSA | AMERICAN | 8 | 28.2 N | 144.2 W | 06 | 20 | 45 | 5 NM | 02 | 1003.7 | 21.7 | 21.2 | 7 | 10 | 20 | 11 | 19.5 |
| STREAM RUDDER | LIBERIAN | 8 | 35.3 N | 144.5 W | 00 | 29 M | 36 | 5 NM | 07 | 995.5 | 12.0 | 14.0 | 8 | 19.5 | 29 | >13 | 36 |
| VIOLET | LIBERIAN | 8 | 47.5 N | 138.3 W | 00 | 15 M | 41 | 5 NM | 03 | 985.0 | 13.0 | 9.0 | 5 | 6.5 | 24 | 6 | 10 |
| CHEVRON COLORADO | AMERICAN | 8 | 41.3 N | 125.2 W | 00 | 16 M | 46 | 10 NM | 60 | 1014.8 | 14.4 | | 3 | 6.5 | 18 | 7 | 10 |
| CALIFORNIAN | AMERICAN | 8 | 32.3 N | 136.5 W | 12 | 27 | 45 | 5 NM | 29 | 998.0 | 18.3 | 18.3 | 6 | 23 | | | |
| OVERSEAS OHIO | AMERICAN | 9 | 43.3 N | 129.3 W | 00 | 12 | 00 | 5 NM | 02 | 997.2 | 12.8 | 9.4 | | | 15 | 8 | 14.5 |
| SEATRAIN PRINCETON | GERMAN | 9 | 33.5 N | 148.5 W | 00 | 26 | 52 | 5 NM | 25 | 999.0 | 16.0 | 16.5 | 7 | 8 | 28 | 8 | 19.5 |
| OVERSEAS NATALIE | AMERICAN | 9 | 45.9 N | 131.5 W | 06 | 16 | 42 | 5 NM | 01 | 989.8 | 11.2 | 10.0 | | 6.5 | 17 | X | 23 |
| SEVEN OCEAN | JAPANESE | 9 | 39.1 N | 173.3 W | 18 | 29 M | 47 | 1 NM | | 989.5 | 11.0 | 12.0 | 6 | 24.5 | 29 | 7 | 26 |
| STREAM RUDDER | LIBERIAN | 9 | 35.3 N | 172.3 W | 18 | 28 M | 43 | 2 NM | 18 | 1004.5 | 9.5 | 14.5 | 6 | 10 | 28 | 10 | 29.5 |
| MOBIL MERICIAN | AMERICAN | 9 | 54.4 N | 158.8 W | 00 | 14 | 47 | 1 NM | 53 | 991.9 | 7.2 | 8.8 | 5 | 10 | 14 | 9 | 24.5 |
| AXEL MAERSK | DANISH | 9 | 37.3 N | 133.5 E | 18 | 32 | 42 | 5 NM | 83 | 1013.6 | 2.3 | | 6 | 13 | | | |
| BRIGIT MAERSK | DANISH | 9 | 51.1 N | 157.0 W | 06 | 29 | 45 | 1 NM | 07 | 977.0 | 3.0 | | 6 | 13 | | | |
| CHEVRON CALIFORNIA | AMERICAN | 9 | 58.8 N | 144.8 W | 00 | 12 | 45 | .25 NM | 45 | 989.5 | 0.1 | 3.3 | 8 | 32.8 | | | |
| STREAM RUDDER | LIBERIAN | 10 | 35.2 N | 173.1 W | 00 | 28 M | 43 | 5 NM | 07 | 1008.0 | 11.5 | 14.5 | 6 | 19.5 | 29 | >13 | 32.5 |
| SEVEN OCEAN | JAPANESE | 10 | 39.2 N | 178.3 W | 06 | 29 M | 47 | .5 NM | | 996.0 | 12.4 | 12.0 | 7 | 29.5 | | | |
| PRES PIERCE | AMERICAN | 10 | 41.7 N | 171.6 E | 18 | 19 | 50 | 5 NM | 82 | 994.2 | 9.0 | 9.0 | | | | | |
| MICHIGAN | AMERICAN | 11 | 29.0 N | 145.8 E | 00 | 33 | 45 | 10 NM | 01 | 1018.4 | 12.0 | 20.0 | 4 | 6.5 | 33 | 8 | 14.5 |
| VAN ENTERPRISE | LIBERIAN | 11 | 46.6 N | 169.0 E | 18 | 23 M | 36 | 5 NM | 18 | 986.0 | 2.5 | 2.0 | | | | | |
| CALIFORNIAN | AMERICAN | 11 | 26.0 N | 148.6 W | 18 | 28 | 00 | 2 NM | 82 | 1005.0 | 17.2 | 22.8 | 5 | 10 | 28 | 8 | 23 |
| PRES PIERCE | AMERICAN | 11 | 42.8 N | 176.8 E | 06 | 17 | 00 | 2 NM | 63 | 980.0 | 9.5 | 6.7 | 12 | 23 | 14 | 13 | 32.5 |
| SEATRAIN PRINCETON | GERMAN | 11 | 29.7 N | 150.5 W | 06 | 31 | 44 | 5 NM | 01 | 1010.0 | 15.0 | 19.7 | 3 | 8 | 29 | 6 | 26 |
| EXPORT BANNER | AMERICAN | 12 | 34.4 N | 137.9 W | 18 | 20 | 45 | 5 NM | 02 | 987.1 | 16.7 | 17.7 | 6 | 11.5 | 24 | 12 | 29.5 |
| VAN ENTERPRISE | LIBERIAN | 12 | 46.6 N | 168.5 E | 06 | 23 M | 52 | 2 NM | 18 | 979.0 | 1.0 | 1.0 | | | 27 | >13 | 49 |
| CALIFORNIAN | AMERICAN | 12 | 25.6 N | 148.1 W | 00 | 29 | 45 | 10 NM | 25 | 1007.0 | 18.9 | 22.8 | 14 | 32.5 | | | |
| BRIGIT MAERSK | DANISH | 12 | 50.7 N | 176.0 E | 12 | 22 | 46 | 2 NM | 83 | 958.5 | 2.0 | 4.0 | 6 | 29.5 | | | |
| STREAM RUDDER | LIBERIAN | 13 | 34.4 N | 167.5 E | 18 | 29 M | 45 | 2 NM | 18 | 1005.1 | 10.0 | 15.0 | 5 | 8 | 29 | 10 | 14.5 |
| SPRUCE | JAPANESE | 13 | 48.8 N | 162.2 E | 12 | 34 M | 45 | .5 NM | 93 | 977.5 | 0.5 | 2.0 | 8 | 13 | 13 | 9 | 19.5 |
| VAN CONQUEROR | LIBERIAN | 13 | 37.2 N | 122.4 W | 18 | 14 M | 30 | 5 NM | 04 | 1016.0 | 14.0 | 14.0 | | | | | |
| VAN ENTERPRISE | LIBERIAN | 13 | 46.9 N | 165.8 E | 06 | 25 M | 48 | 2 NM | 83 | 972.0 | 2.0 | 2.0 | | | 27 | 9 | 26 |
| ARNOLD MAERSK | DANISH | 13 | 52.2 N | 174.5 E | 06 | 19 | 45 | 2 NM | 26 | 981.0 | 3.0 | | 11 | 24.5 | | | |
| CHEVRON CALIFORNIA | AMERICAN | 13 | 39.2 N | 124.6 W | 12 | 15 | 45 | .5 NM | 65 | 1012.4 | 13.3 | 10.0 | 4 | 13 | 15 | 6 | 16.5 |
| BRIGIT MAERSK | DANISH | 13 | 50.6 N | 173.7 E | 00 | 22 | 48 | 1 NM | 83 | 981.0 | 2.0 | 4.0 | 8 | 29.5 | | | |
| EXPORT BANNER | AMERICAN | 13 | 35.0 N | 136.9 W | 00 | 22 | 30 | 10 NM | 25 | 987.0 | 15.0 | 17.2 | 7 | 14.5 | 23 | >13 | 36 |
| AMER APOLLO | AMERICAN | 13 | 35.5 N | 168.1 E | 12 | 29 | 30 | 5 NM | 81 | 998.4 | 8.9 | 15.6 | 6 | 13 | 29 | 6 | 16.5 |
| ORIENTAL STATESMAN | LIBERIAN | 13 | 34.0 N | 173.9 E | 06 | 26 M | 44 | 2 NM | 65 | 996.5 | 16.5 | 17.0 | 7 | 11.5 | | | |
| BRIGIT MAERSK | DANISH | 14 | 50.0 N | 166.0 E | 12 | 29 | 45 | 1 NM | 83 | 976.5 | 2.0 | 4.0 | 8 | 29.5 | | | |
| ADRIAN MAERSK | DANISH | 14 | 34.5 N | 126.7 W | 19 | 18 | 41 | 2 NM | 81 | 996.5 | 17.0 | 18.0 | 8 | 6.5 | 18 | 13 | 19.5 |
| VAN CONQUEROR | LIBERIAN | 14 | 36.6 N | 122.8 W | 00 | 16 M | 45 | 5 NM | 63 | 1014.0 | 14.0 | 14.0 | | | | | |
| SPRUCE | JAPANESE | 14 | 42.8 N | 162.0 E | 18 | 30 M | 42 | 2 NM | 02 | 1004.5 | 0.8 | 4.0 | 8 | 14.5 | 12 | 9 | 16.5 |
| STREAM RUDDER | LIBERIAN | 14 | 34.1 N | 166.7 E | 00 | 29 M | 43 | 10 NM | 18 | 1009.5 | 11.0 | 17.5 | 6 | 16.5 | 29 | 12 | 19.5 |
| KOREA PHOENIX | SINGAPORE | 14 | 42.6 N | 124.7 W | 11 | 19 M | 45 | 200 YD | 63 | 1000.5 | 11.0 | | 5 | 10 | | | |
| HAWAIIAN CITIZEN | AMERICAN | 14 | 35.4 N | 141.7 W | 18 | 28 | 45 | 5 NM | 01 | 1000.5 | 10.8 | 17.8 | | 29.5 | | | |
| EXPORT BANNER | AMERICAN | 14 | 36.6 N | 129.3 W | 12 | 20 | 42 | 5 NM | 07 | 993.5 | 14.5 | 16.2 | 7 | 10 | 18 | 8 | 19.5 |
| PRES HARRISON | AMERICAN | 14 | 36.1 N | 165.8 W | 12 | 33 | 45 | 5 NM | 63 | 991.5 | 12.8 | 12.8 | 4 | 11.5 | 13 | 8 | 18 |
| PRES TRUMAN | AMERICAN | 14 | 47.7 N | 180.8 E | 06 | 30 | 50 | 5 NM | 02 | 982.0 | - 3.0 | 1.1 | 5 | 13 | 31 | 9 | 32.5 |
| ARCO PRUDHOE BAY | AMERICAN | 14 | 49.5 N | 128.2 W | 03 | 11 | 47 | 2 NM | 07 | 998.9 | 10.0 | 6.7 | | | | | |

| Vessel | Nationality | Date | Position of Ship | | Time GMT | Wind | | Visibility n. mi. | Present Weather code | Pressure mb. | Temperature °C | | Sea Waves* | | Swell Waves | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Lat. deg. | Long. deg. | | Dir. 10° | Speed kt. | | | | Air | Sea | Period sec. | Height ft. | Dir. 10° | Period sec. | Height ft. |
| NORTH PACIFIC OCEAN | | JAN. | | | | | | | | | | | | | | | |
| YAMASHIN MARU | JAPANESE | 15 | 35.1 N | 142.0 W | 06 | 29 | M 41 | 7 NM | 02 | 998.0 | 14.0 | 15.0 | 5 | 8 | 30 | 10 | 16.5 |
| TRIUMPH | PANAMANIAN | 15 | 36.4 N | 147.6 E | 19 | 27 | M 44 | 5 NM | 01 | 1001.7 | 16.0 | 20.0 | 7 | 14.5 | 27 | 10 | 19.5 |
| SPRUCE | JAPANESE | 15 | 40.7 N | 157.9 E | 12 | 27 | M 43 | 7 NM | 02 | 1004.0 | 8.6 | 8.0 | 6 | 10 | 12 | 8 | 14.5 |
| AMERICAN | AMERICAN | 15 | 50.6 N | 177.3 E | 00 | 21 | 45 | 5 NM | 16 | 978.3 | 2.2 | 3.3 | 6 | 5 | 24 | 11 | 19.5 |
| PRES FILLMORE | AMERICAN | 15 | 40.6 N | 158.9 E | 00 | 32 | 45 | 10 NM | 85 | 1004.7 | 5.0 | 12.2 | 7 | 10 | 32 | 10 | 19.5 |
| YAMASHIN MARU | JAPANESE | 16 | 33.9 N | 139.5 W | 03 | 26 | M 43 | 7 NM | 25 | 997.0 | 15.5 | 16.0 | 5 | 8 | 27 | 9 | 14.5 |
| WALTER RICE | AMERICAN | 16 | 37.3 N | 123.9 W | 12 | 21 | 45 | 7 NM | 61 | 998.0 | 15.0 | 11.2 | 4 | 6.5 | 24 | 10 | 16.5 |
| CHEVRON WASHINGTON | AMERICAN | 16 | 41.4 N | 124.7 W | 05 | 18 | 45 | 5 NM | 63 | 995.9 | 11.1 | | 2 | 8 | 18 | < 6 | 11.5 |
| VAN WARRIOR | LIBERIAN | 16 | 46.6 N | 173.2 E | 18 | 18 | 45 | 5 NM | 03 | 971.0 | 4.0 | 4.0 | | | | | |
| SEALAND COMMERCE | AMERICAN | 16 | 25.5 N | 121.5 E | 18 | 05 | 45 | 5 NM | 02 | 1021.5 | 10.0 | 17.7 | 5 | 8 | 04 | < 6 | 13 |
| SEALAND MC LEAN | AMERICAN | 16 | 40.0 N | 153.3 E | 06 | 29 | 48 | 10 NM | 02 | 1000.0 | 2.2 | 7.2 | 7 | 14.5 | 29 | 12 | 11.5 |
| SPRUCE | JAPANESE | 16 | 39.6 N | 154.0 E | 06 | 29 | M 45 | 2 NM | 91 | 1000.1 | 4.0 | 14.0 | 9 | 23 | 15 | 8 | 23 |
| HOLLAND MARU | JAPANESE | 16 | 28.0 N | 160.8 W | 18 | 29 | M 45 | 10 NM | 01 | 1006.0 | 17.5 | 20.0 | 4 | 8 | 30 | 8 | 14.5 |
| PRES KENNEDY | AMERICAN | 16 | 36.9 N | 132.1 W | 18 | 28 | 45 | 2 NM | 81 | 997.6 | 13.9 | 13.9 | 6 | 10 | 28 | 10 | 11.5 |
| WASHINGTON RAINBOW | JAPANESE | 17 | 32.6 N | 156.6 W | 00 | 32 | M 00 | .25 NM | | 992.0 | 11.0 | 10.0 | 9 | 16 | 32 | 9 | 18 |
| VAN WARRIOR | LIBERIAN | 17 | 46.1 N | 171.0 E | 18 | 27 | 70 | .25 NM | 72 | 977.0 | 4.0 | 4.0 | | | | | |
| SPRUCE | JAPANESE | 17 | 37.7 N | 149.4 E | 06 | 29 | M 41 | 2 NM | 87 | 1011.0 | 5.8 | 13.0 | 9 | 21 | 13 | 9 | 21 |
| NORSH TRANSPORTER | NORWEGIAN | 17 | 44.3 N | 170.0 E | 00 | 26 | 45 | .5 NM | 49 | 997.7 | 2.0 | 6.5 | 10 | 32.5 | | | |
| GENEVIRVE LYKES | AMERICAN | 17 | 22.1 N | 121.1 E | 00 | 03 | M 45 | 2 NM | 18 | 1018.0 | 17.5 | 20.6 | 6 | 11.5 | | | |
| ATLANTIC PIONEER | PANAMANIAN | 17 | 34.2 N | 177.4 E | 12 | 23 | M 48 | 1 NM | 05 | 1002.7 | 16.5 | 15.0 | 7 | 14.5 | 23 | 13 | 24.5 |
| PRES POLK | AMERICAN | 17 | 46.1 N | 159.1 E | 00 | 31 | 50 | 5 NM | 22 | 996.6 | - 2.8 | 2.2 | 12 | 28 | XX | X | 16.5 |
| ORIENTAL STATESMAN | LIBERIAN | 17 | 33.8 N | 141.7 W | 12 | 18 | M 46 | 2 NM | 61 | 1000.0 | 16.0 | 17.0 | | | | | |
| PRES JEFFERSON | AMERICAN | 18 | 40.1 N | 177.4 E | 18 | 28 | 50 | 10 NM | 70 | 1002.2 | 4.4 | 10.8 | 6 | 19.5 | 29 | 9 | 29.5 |
| MONTANA | AMERICAN | 18 | 28.4 N | 145.6 W | 00 | 29 | 45 | 10 NM | 01 | 1015.0 | 17.2 | 20.0 | 4 | 8 | 29 | 8 | 29.5 |
| SHUNWIND | LIBERIAN | 18 | 47.0 N | 167.0 E | 06 | 30 | M 48 | 2 NM | 70 | 994.0 | 0.0 | 5.0 | 6 | 19.5 | 32 | 8 | 32.5 |
| VAN WARRIOR | LIBERIAN | 18 | 46.1 N | 170.4 E | 00 | 29 | 70 | .25 NM | 73 | 983.0 | 4.0 | 5.0 | | | | | |
| VIOLET | LIBERIAN | 18 | 38.1 N | 133.8 W | 00 | 18 | M 44 | 1 NM | 25 | 1001.5 | 17.0 | 13.0 | 6 | 6.5 | 24 | 7 | 8 |
| PRES JEFFERSON | AMERICAN | 19 | 39.9 N | 177.1 W | 06 | 29 | 50 | 10 NM | 70 | 1003.6 | 5.8 | 9.4 | 6 | 24.5 | 30 | 9 | 32.5 |
| VAN WARRIOR | LIBERIAN | 19 | 46.3 N | 167.5 E | 00 | 29 | 50 | 5 NM | 71 | 1006.0 | 2.0 | 7.0 | | | | | |
| CORAL ARCADIA | LIBERIAN | 19 | 39.4 N | 147.4 E | 18 | 32 | M 44 | 5 NM | 07 | 998.5 | 7.0 | 12.5 | 7 | 14.5 | | | |
| PRES JEFFERSON | AMERICAN | 20 | 40.3 N | 168.8 W | 00 | 27 | 40 | 10 NM | 02 | 1005.6 | 13.3 | 9.4 | 6 | 19.5 | 26 | 7 | 36 |
| NORSH TRANSPORTER | NORWEGIAN | 20 | 39.7 N | 154.8 E | 06 | 28 | 41 | 5 NM | 02 | 994.0 | 7.0 | 14.0 | | 26 | | | |
| VAN WARRIOR | LIBERIAN | 20 | 44.3 N | 158.5 E | 06 | 28 | 45 | 5 NM | 70 | 962.0 | 5.0 | 2.0 | | | | | |
| PRESIDENT MADISON | AMERICAN | 21 | 36.9 N | 168.6 E | 06 | 29 | 45 | 10 NM | 01 | 1002.0 | 10.0 | 14.4 | 7 | 14.5 | 27 | 7 | 23 |
| PRES EISENHOWER | AMERICAN | 21 | 32.7 N | 145.5 E | 18 | 27 | 45 | 10 NM | 62 | 1000.2 | 12.8 | 18.4 | 8 | 11.5 | 27 | 10 | 29.5 |
| VAN WARRIOR | LIBERIAN | 21 | 40.5 N | 149.6 E | 18 | 11 | 50 | 1 NM | 65 | 998.0 | 9.0 | 10.0 | | | | | |
| TEXAS TRADER | AMERICAN | 21 | 33.4 N | 140.3 E | 18 | 27 | 45 | 5 NM | 25 | 1004.4 | 7.2 | 19.3 | 3 | 8 | 28 | 6 | 24.5 |
| SHUNWIND | LIBERIAN | 22 | 40.4 N | 146.6 E | 09 | 26 | M 50 | 5 NM | 07 | 976.5 | 3.5 | 9.0 | 6 | 26 | 29 | 9 | 42.5 |
| VAN WARRIOR | LIBERIAN | 22 | 39.4 N | 147.3 E | 12 | 27 | 65 | 5 NM | 03 | 983.0 | 6.0 | 10.0 | | | | | |
| WALTER RICE | AMERICAN | 22 | 15.0 N | 94.7 W | 18 | 36 | 45 | 5 NM | 05 | 1012.9 | 24.2 | 26.1 | 4 | 8 | | | |
| DON JUAN | SWEDISH | 22 | 31.3 N | 148.6 E | 12 | 27 | 45 | 5 NM | 18 | 1005.0 | 14.0 | | 4 | 8 | 27 | 11 | 19.5 |
| GREEN AUKLET | PANAMANIAN | 22 | 44.6 N | 152.3 E | 06 | 09 | M 50 | .5 NM | 44 | 981.0 | 1.0 | 3.0 | | | | | |
| NORSH TRANSPORTER | NORWEGIAN | 22 | 36.6 N | 143.7 E | 06 | 28 | 47 | 2 NM | 83 | 991.0 | 8.0 | 19.0 | | 26 | | | |
| SEALAND TRADE | AMERICAN | 22 | 37.7 N | 145.5 E | 06 | 28 | 60 | 5 NM | 23 | 985.5 | 5.5 | 9.5 | 8 | 32.5 | | | |
| SEALAND COMMERCE | AMERICAN | 22 | 39.5 N | 169.0 E | 18 | 15 | 42 | 2 NM | 02 | 981.8 | 10.8 | 10.0 | 5 | 13 | | | |
| PACIFIC WING | PANAMANIAN | 22 | 36.9 N | 168.1 E | 12 | 15 | M 58 | 1 NM | 07 | 993.5 | 13.0 | 13.0 | 5 | 14.5 | 16 | 9 | 21 |
| PRES EISENHOWER | AMERICAN | 22 | 32.7 N | 154.7 E | 18 | 27 | 45 | 10 NM | 02 | 1000.0 | 12.4 | 18.3 | 6 | 19.5 | 27 | 12 | 32.5 |
| PRES TAFT | AMERICAN | 22 | 38.4 N | 145.1 E | 06 | 27 | 55 | 5 NM | 02 | 995.0 | 6.7 | 12.5 | 6 | 14.5 | 27 | 12 | 21 |
| AMER AQUARIUS | AMERICAN | 22 | 33.4 N | 140.1 E | 18 | 32 | 50 | 10 NM | 02 | 1006.4 | 7.8 | 16.7 | 5 | 19.5 | 32 | >13 | 23 |
| NORSE PILOT | BRITISH | 22 | 30.8 N | 141.0 E | 06 | 30 | M 45 | 3 NM | 07 | 1009.0 | 12.5 | 12.0 | 7 | 8 | 30 | 7 | 19.5 |
| VAN WARRIOR | LIBERIAN | 23 | 39.1 N | 146.0 E | 00 | 31 | 65 | 5 NM | 79 | 1001.0 | 5.0 | 10.0 | | | | | |
| ALSTER EXPRESS | GERMAN | 23 | 47.8 N | 158.5 E | 06 | 06 | 52 | .5 NM | 86 | 981.5 | - 0.5 | 1.0 | 6 | 29.5 | | | |
| GREEN AUKLET | PANAMANIAN | 23 | 42.2 N | 146.7 E | 06 | 32 | M 48 | 1 NM | 07 | 998.0 | - 2.0 | 3.0 | | | | | |
| ILLINOIS | AMERICAN | 23 | 54.3 N | 167.3 W | 10 | 27 | 45 | 5 NM | 26 | 987.1 | 2.2 | 1.7 | 4 | 11.5 | 27 | 7 | 19.5 |
| HONGKONG PHOENIX | SINGAPORE | 23 | 40.6 N | 148.1 E | 00 | 29 | 50 | .25 NM | 44 | 991.5 | 1.0 | 9.0 | 5 | 19.5 | 33 | 12 | 18 |
| GOLDEN BEAR | AMERICAN | 23 | 42.3 N | 149.8 E | 06 | 32 | M 50 | 2 NM | 71 | 983.0 | 0.0 | 1.7 | | 32.5 | 32 | X | 49 |
| SANTA CLARA | AMERICAN | 23 | 50.0 N | 151.7 W | 00 | 10 | 50 | .25 NM | | 988.5 | 2.7 | 5.5 | 3 | 10 | 10 | 8 | 29.5 |
| AMERICA MARU | JAPANESE | 23 | 38.1 N | 146.5 W | 06 | 13 | M 42 | 5 NM | 03 | 1001.5 | 14.0 | 20.0 | 5 | 6.5 | 19 | 7 | 16.5 |
| AMER AQUARIUS | AMERICAN | 23 | 32.6 N | 147.7 E | 00 | 31 | 45 | 10 NM | 15 | 1011.1 | 9.4 | 16.7 | 7 | 32.5 | 33 | 11 | 26 |
| NEW ENGLAND HUNTER | LIBERIAN | 23 | 27.3 N | 195.4 E | 06 | 31 | 41 | 10 NM | 03 | 1009.8 | 18.5 | 22.0 | 4 | 13 | 30 | 12 | 26 |
| OVERSEAS NATALIE | AMERICAN | 23 | 38.2 N | 145.1 W | 00 | 14 | 50 | 2 NM | 10 | 996.3 | 3.9 | 6.1 | | | 13 | 6 | 14.5 |
| PRES EISENHOWER | AMERICAN | 23 | 32.8 N | 161.4 E | 12 | 28 | 45 | 10 NM | 16 | 1001.0 | 14.4 | 18.9 | 6 | 19.5 | 28 | 12 | 32.5 |
| OVERSEAS NATALIE | AMERICAN | 24 | 31.1 N | 138.5 W | 12 | 18 | 45 | 5 NM | 10 | 1007.5 | 8.4 | 5.7 | | | 19 | 6 | 14.5 |
| PRES EISENHOWER | AMERICAN | 24 | 32.8 N | 170.4 E | 12 | 28 | 45 | 10 NM | 02 | 1003.0 | 13.9 | 17.2 | 6 | 19.5 | 28 | 12 | 32.5 |
| ALSTER EXPRESS | GERMAN | 24 | 44.6 N | 153.9 E | 00 | 34 | 44 | .25 NM | 86 | 992.0 | - 0.5 | 2.0 | 5 | 23 | XX | X | 26 |
| HONGKONG PHOENIX | SINGAPORE | 24 | 38.5 N | 155.0 E | 00 | 31 | 45 | .25 NM | 86 | 996.0 | 4.0 | 15.0 | 5 | 24.5 | 31 | 12 | 23 |
| MAINE | AMERICAN | 25 | 39.7 N | 164.2 E | 23 | 26 | 55 | 2 NM | 65 | 989.5 | 7.5 | 10.0 | 8 | 19.5 | 26 | >13 | 32.5 |
| PRES EISENHOWER | AMERICAN | 25 | 32.9 N | 175.0 E | 00 | 28 | 45 | 10 NM | 02 | 1009.4 | 16.7 | 17.2 | 6 | 19.5 | 28 | 12 | 32.5 |
| HONGKONG PHOENIX | SINGAPORE | 25 | 37.3 N | 162.9 E | 18 | 24 | 60 | .5 NM | 79 | 982.0 | 12.0 | 15.0 | 15 | 29.5 | | | |
| MAINE | AMERICAN | 26 | 39.6 N | 168.0 E | 12 | 26 | 46 | 2 NM | 15 | 990.8 | 4.5 | 11.1 | 5 | 11.5 | 26 | 13 | 28 |
| HONGKONG PHOENIX | SINGAPORE | 26 | 37.4 N | 163.5 E | 00 | 27 | 50 | .5 NM | 93 | 987.5 | 8.0 | 15.0 | 15 | 29.5 | 24 | >13 | 24.5 |
| ILLINOIS | AMERICAN | 26 | 45.5 N | 156.0 E | 06 | 33 | 55 | 2 NM | 70 | 997.3 | - 6.7 | - 0.6 | 6 | 16.5 | 34 | 12 | 29.5 |
| GREEN ECHO | LIBERIAN | 26 | 46.7 N | 158.1 E | 12 | 36 | M 48 | .25 NM | 72 | 1000.0 | - 1.0 | 0.0 | 10 | 16.5 | | | |
| MAINE | AMERICAN | 27 | 39.1 N | 173.3 E | 06 | 28 | 45 | 10 NM | 03 | 998.8 | 6.0 | 9.0 | 6 | 8 | 28 | 11 | 29.5 |
| MIDAS ARROW | LIBERIAN | 27 | 34.8 N | 158.5 E | 12 | 18 | M 55 | 1 NM | 21 | 995.2 | 15.0 | 15.0 | 8 | 13 | 18 | 10 | 31 |
| ZIM TOKYO | GERMAN | 27 | 33.9 N | 142.8 E | 00 | 27 | 50 | 2 NM | 25 | 999.0 | 14.4 | 15.4 | 7 | 16.5 | | | |
| AXEL MAERSK | DANISH | 27 | 35.3 N | 151.5 E | 18 | 33 | 48 | 2 NM | 01 | 1002.1 | 12.0 | | 10 | 19.5 | 31 | 13 | 29.5 |
| ILLINOIS | AMERICAN | 27 | 39.8 N | 146.5 E | 06 | 06 | 50 | 1 NM | 88 | 999.4 | 3.9 | 2.2 | 6 | 14.5 | 06 | 10 | 29.5 |
| MIDAS ARROW | LIBERIAN | 28 | 34.9 N | 159.1 E | 00 | 27 | M 55 | .25 NM | | 987.6 | 12.0 | 17.0 | 12 | 16.5 | 28 | 12 | 31 |
| AXEL MAERSK | DANISH | 28 | 35.2 N | 153.9 E | 00 | 33 | 48 | 5 NM | 02 | 1007.5 | 11.6 | 16.0 | 10 | 29.5 | 28 | 7 | 19.5 |
| STREAM RUDDER | LIBERIAN | 28 | 31.1 N | 180.3 E | 00 | 27 | M 44 | 5 NM | 05 | 1007.1 | 16.5 | 18.5 | 9 | 13 | 23 | 11 | 19.5 |
| SEATRAIN PRINCETON | GERMAN | 28 | 35.5 N | 170.7 E | 18 | 30 | 60 | 2 NM | 80 | 992.5 | 10.8 | 14.8 | 12 | 23 | 28 | >13 | 32.5 |
| HONGKONG PHOENIX | SINGAPORE | 28 | 38.5 N | 178.9 W | 18 | 22 | 65 | 2 NM | 80 | 988.5 | 12.0 | 14.0 | | | | | |
| CRYSTAL REED | PANAMANIAN | 28 | 31.1 N | 183.4 E | 06 | 28 | M 42 | 2 NM | 02 | 1005.0 | 12.0 | 14.0 | | | | | |
| SEATRAIN PRINCETON | GERMAN | 29 | 35.6 N | 173.2 E | 00 | 30 | 55 | 5 NM | 01 | 1005.0 | 11.3 | 12.2 | 12 | 23 | 30 | >13 | 29.5 |
| KOREA PHOENIX | SINGAPORE | 29 | 48.6 N | 159.5 E | 05 | 26 | M 55 | 5 NM | 41 | 1000.0 | - 5.0 | - 0.5 | 6 | 10 | | | |
| HONGKONG PHOENIX | SINGAPORE | 29 | 39.3 N | 176.5 W | 06 | 27 | 55 | 1 NM | 80 | 986.5 | 12.0 | 14.0 | 6 | 24.5 | 25 | >13 | 19.5 |
| MIDAS ARROW | LIBERIAN | 30 | 33.5 N | 175.7 E | 18 | 27 | M 53 | 1 NM | 21 | 997.6 | 14.5 | 17.0 | 10 | 26 | | | |
| HONGKONG PHOENIX | SINGAPORE | 30 | 40.9 N | 169.6 W | 06 | 28 | 50 | 2 NM | 03 | 996.5 | 7.0 | 13.0 | 7 | 24.5 | 25 | >13 | 18 |
| PRES VAN BUREN | AMERICAN | 30 | 38.7 N | 149.6 E | 12 | 28 | 36 | 2 NM | 80 | 984.0 | 15.0 | 12.2 | | | | | |
| HONGKONG PHOENIX | SINGAPORE | 31 | 39.8 N | 160.0 W | 18 | 15 | 50 | .5 NM | 62 | 982.0 | 10.0 | 10.0 | 6 | 16.5 | 18 | 10 | 14.5 |
| THOMAS E CUFFE | AMERICAN | 31 | 31.5 N | 174.0 E | 00 | 31 | 42 | 10 NM | 01 | 1012.1 | 14.5 | 17.8 | 6 | 10 | 31 | 10 | 21 |
| CRESSIDA | PANAMANIAN | 31 | 41.7 N | 153.3 E | 12 | 28 | M 51 | 2 NM | 22 | 995.5 | 0.0 | | 5 | 19.5 | 25 | 8 | 16.5 |
| ANCO DUKE | BRITISH | 31 | 49.9 N | 170.6 E | 00 | 32 | 41 | .5 NM | 08 | 995.2 | 2.0 | 2.8 | 8 | 16.5 | | | |
| CRYSTAL REED | PANAMANIAN | 31 | 31.2 N | 174.9 W | 12 | 31 | M 43 | 2 NM | 03 | 1006.5 | 17.0 | 16.0 | 5 | 6.5 | 31 | >13 | 13 |
| AXEL MAERSK | DANISH | 31 | 33.0 N | 171.4 W | 12 | 30 | 57 | 5 NM | 25 | 996.9 | 12.3 | | 10 | 29.5 | | | |
| PRES VAN BUREN | AMERICAN | 31 | 35.0 N | 173.8 E | 00 | 31 | 47 | 5 NM | 25 | 1007.0 | 11.1 | 12.8 | 5 | 10 | 31 | >13 | 29.5 |
| MIDAS ARROW | LIBERIAN | 31 | 33.5 N | 176.9 E | 00 | 29 | M 43 | 1 NM | 05 | 1001.6 | 15.8 | 16.5 | 10 | 24.5 | | | |

| Vessel | Nationality | Date | Position of Ship | | Time GMT | Wind | | Visibility n. mi. | Present Weather code | Pressure mb | Temperature °C | | Sea Waves* | | Swell Waves | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Lat. deg. | Long. deg. | | Dir. 10° | Speed kt. | | | | Air | Sea | Period sec. | Height ft. | Dir. 10° | Period sec. | Height ft. |
| NORTH PACIFIC OCEAN | | FEB. | | | | | | | | | | | | | | | |
| HONGKONG PHOENIX | SINGAPORE | 1 | 39.9 N | 157.4 W | 06 | 21 | 43 | 2 NM | 03 | 980.0 | 10.0 | 12.0 | 10 | 24.5 | 18 | >13 | 23 |
| SEALAND MC LEAN | AMERICAN | 1 | 38.3 N | 171.0 W | 00 | 33 | 60 | 5 NM | 02 | 992.5 | 6.1 | 8.9 | 13 | 52.5 | | | |
| AXEL MAERSK | DANISH | 1 | 32.9 N | 166.5 W | 00 | 30 | 50 | 5 NM | 25 | 1001.5 | | 14.0 | 10 | 23 | 30 | 10 | 32.5 |
| PRES KENNEDY | AMERICAN | 1 | 41.8 N | 148.2 E | 00 | 27 | 45 | 10 NM | 01 | 998.3 | - 1.0 | 3.4 | 6 | 10 | 27 | >13 | 19.5 |
| ARCO DUKE | BRITISH | 2 | 44.3 N | 159.3 E | 06 | 28 | 49 | 10 NM | 22 | 985.4 | - 1.7 | 1.7 | | | 27 | 9 | 16.5 |
| PACIFIC ARROW | JAPANESE | 2 | 30.5 N | 162.1 W | 12 | 24 | N 44 | 2 NM | 82 | 1004.5 | 16.0 | 17.2 | | | | | |
| PHILADELPHIA | AMERICAN | 4 | 57.1 N | 149.2 W | 12 | 08 | 45 | 5 NM | 02 | 984.1 | 3.9 | 4.4 | 4 | 13 | 08 | < 6 | 19.5 |
| GOLDEN GATE BRIDGE | JAPANESE | 5 | 35.8 N | 157.2 W | 18 | 26 | N 44 | 10 NM | 25 | 987.6 | 12.0 | 13.0 | 5 | 6.5 | 25 | 10 | 16.5 |
| HONGKONG PHOENIX | SINGAPORE | 5 | 47.0 N | 128.1 W | 18 | 13 | 43 | .25 NM | 80 | 985.0 | 9.0 | 10.0 | 5 | 14.5 | 18 | >13 | 13 |
| LONG BEACH | PANAMANIAN | 5 | 31.7 N | 141.5 E | 18 | 28 | N 46 | 2 NM | 19 | 1001.5 | 12.0 | 11.0 | 6 | 13 | 28 | 11 | 18 |
| PRES TRUMAN | AMERICAN | 5 | 36.3 N | 148.2 E | 06 | 29 | 45 | 2 NM | 86 | 1006.0 | 2.7 | 10.7 | 5 | 6.5 | 29 | >13 | 26 |
| SEALAND EXCHANGE | AMERICAN | 5 | 38.0 N | 145.8 E | 06 | 29 | 50 | 5 NM | 26 | 1005.1 | 1.1 | 10.5 | 6 | 18 | | | |
| ARCO DUKE | BRITISH | 5 | 38.4 N | 147.1 E | 06 | 30 | 50 | 5 NM | 26 | 1002.0 | 0.0 | 13.0 | 6 | 23 | 30 | 8 | 26 |
| MOBIL MERIDIAN | AMERICAN | 6 | 57.0 N | 143.8 W | 00 | 16 | 45 | 5 NM | 58 | 955.0 | 5.0 | 4.5 | 6 | 10 | 16 | 9 | 13 |
| GOLDEN ORCHID | LIBERIAN | 6 | 33.2 N | 138.0 W | 00 | 21 | N 45 | 5 NM | 01 | 998.0 | 18.0 | 16.0 | 6 | 13 | 21 | >13 | 21 |
| SANSINENA II | AMERICAN | 6 | 42.8 N | 127.5 W | 06 | 22 | 50 | 5 NM | 60 | 986.5 | 10.6 | 8.9 | 7 | 14.5 | 20 | 12 | 24.5 |
| SANTA MARIA | AMERICAN | 6 | 43.7 N | 124.8 W | 18 | 17 | 45 | 5 NM | 02 | 992.6 | 11.7 | 12.2 | 9 | 16.5 | | | |
| PHILADELPHIA | AMERICAN | 6 | 54.7 N | 138.1 W | 00 | 11 | 25 | 2 NM | 51 | 969.2 | 8.3 | 9.0 | 6 | 23 | 11 | 8 | 32.5 |
| HANISTEE | BRITISH | 6 | 13.8 N | 94.4 W | 00 | 33 | 45 | 5 NM | 02 | 1014.2 | 24.0 | 27.8 | 4 | 10 | | | |
| SANTA MARIA | AMERICAN | 7 | 41.2 N | 125.3 W | 12 | 17 | 48 | 2 NM | 81 | 990.2 | 11.1 | 13.3 | | | | | |
| PRES JOHNSON | AMERICAN | 8 | 53.0 N | 138.5 W | 12 | 31 | 55 | 1 NM | 65 | 971.5 | 2.2 | 6.7 | 7 | 16.5 | | | |
| OVERSEAS NATALIE | AMERICAN | 8 | 39.9 N | 125.3 W | 18 | 18 | 53 | 5 NM | 81 | 998.2 | 11.7 | 11.7 | 6 | 6 | 17 | 11 | 19.5 |
| MOBIL MERIDIAN | AMERICAN | 8 | 48.3 N | 126.7 W | 18 | 16 | 45 | 2 NM | 50 | 991.8 | 9.0 | 7.7 | 6 | 8 | 20 | 8 | 14.5 |
| GREAT LAND | AMERICAN | 8 | 52.2 N | 132.1 W | 00 | 18 | N 60 | 2 NM | 62 | 988.5 | 9.0 | 6.5 | | | 35 | 8 | 32.5 |
| PRES JOHNSON | AMERICAN | 9 | 53.4 N | 130.0 W | 12 | 30 | 45 | 5 NM | 70 | 988.0 | 2.7 | 3.3 | 7 | 16.5 | 30 | 8 | 19.5 |
| PRES PIERCE | AMERICAN | 9 | 48.9 N | 145.8 W | 18 | 28 | 45 | 2 NM | 70 | 999.7 | 1.1 | 3.9 | 6 | 10 | 28 | 11 | 16.5 |
| ARCO PRUDHOE BAY | AMERICAN | 9 | 51.9 N | 133.5 W | 12 | 06 | 65 | 2 NM | 83 | 967.2 | 2.8 | 6.2 | 6 | 14.5 | 12 | 9 | 23 |
| MUNRO | AMERICAN | 9 | 55.2 N | 157.2 W | 06 | 32 | 43 | 5 NM | 07 | 997.7 | - 3.7 | 3.8 | 5 | 11.5 | | | |
| OVERSEAS NATALIE | AMERICAN | 9 | 38.8 N | 124.5 W | 00 | 18 | 50 | 5 NM | 81 | 998.6 | 13.4 | 13.4 | 3 | 6.5 | 18 | 6 | 18 |
| OVERSEAS NATALIE | AMERICAN | 10 | 33.1 N | 118.4 W | 06 | 16 | 42 | 5 NM | 61 | 1002.0 | 15.3 | 16.2 | | | | | |
| ARCO ANCHORAGE | AMERICAN | 10 | 59.0 N | 144.2 W | 18 | 12 | 45 | 2 NM | 10 | 992.3 | 7.2 | 3.8 | 2 | 5 | 12 | 7 | 19.5 |
| MARCONA EXPORTER | LIBERIAN | 11 | 40.0 N | 157.0 W | 06 | 26 | 48 | 1 NM | | 994.5 | 10.0 | 11.0 | 7 | 13 | | | |
| HAKONE MARU | JAPANESE | 11 | 39.7 N | 177.1 W | 12 | 23 | N 41 | .5 NM | 21 | 999.0 | 10.5 | 14.0 | 5 | 6.5 | 23 | 9 | 13 |
| KINYO MARU | JAPANESE | 11 | 36.5 N | 143.0 W | 21 | 28 | N 40 | 1 NM | 65 | 1006.5 | 14.0 | 14.0 | 7 | 11.5 | 28 | 11 | 32.5 |
| ILLINOIS | AMERICAN | 11 | 38.1 N | 179.9 E | 12 | 22 | 50 | 2 NM | 62 | 999.7 | 12.2 | 10.6 | | | 22 | | 29.5 |
| SEA FAN | SINGAPORE | 11 | 40.7 N | 175.3 E | 06 | 18 | N 48 | .5 NM | 38 | 984.0 | 7.0 | | | | | | |
| PRES ROOSEVELT | AMERICAN | 11 | 37.3 N | 149.8 W | 18 | 29 | 50 | 5 NM | 21 | 1009.2 | 9.4 | 13.3 | 7 | 29.5 | | | |
| PACDUKE | LIBERIAN | 12 | 44.2 N | 144.4 W | 00 | 32 | N 42 | 2 NM | 01 | 982.0 | 10.0 | 9.0 | 13 | 26 | | | |
| VAN CONQUEROR | LIBERIAN | 12 | 51.5 N | 146.5 W | 06 | 35 | N 48 | 5 NM | 60 | 989.0 | 1.0 | 8.0 | | | | | |
| ARCO ANCHORAGE | AMERICAN | 12 | 53.5 N | 135.3 W | 12 | 12 | 43 | 2 NM | 63 | 993.0 | 6.0 | 3.8 | | | 12 | 6 | 19.5 |
| KINYO MARU | JAPANESE | 12 | 36.6 N | 141.2 W | 03 | 29 | N 51 | 2 NM | 02 | 1004.5 | 12.0 | 15.0 | 11 | 14.5 | 29 | 13 | 41 |
| PRES TRUMAN | AMERICAN | 12 | 34.9 N | 147.2 W | 00 | 30 | 40 | 10 NM | 02 | 1014.5 | 11.1 | 12.2 | 7 | 10 | 30 | >13 | 32.5 |
| SPRUCE | JAPANESE | 12 | 47.3 N | 166.6 W | 00 | 18 | N 60 | 1 NM | 25 | 988.5 | 3.5 | 5.5 | 9 | 16.5 | 36 | 9 | 16.5 |
| PRES ROOSEVELT | AMERICAN | 12 | 37.2 N | 147.3 W | 00 | 31 | 45 | 10 NM | 02 | 1008.2 | 11.1 | 12.2 | 8 | 10 | 31 | 10 | 26 |
| IRISH STAR | IRISH | 13 | 38.2 N | 129.3 W | 00 | 27 | 43 | 5 NM | 15 | 1001.5 | 12.8 | 18.0 | 5 | 6.5 | 27 | 12 | 36 |
| PRES JOHNSON | AMERICAN | 13 | 48.9 N | 162.3 E | 00 | 27 | 45 | 1 NM | 74 | 997.0 | - 7.2 | 0.6 | 6 | 10 | 27 | 8 | 16.5 |
| UNIVERSE KURE | LIBERIAN | 14 | 40.3 N | 171.3 E | 12 | 29 | N 48 | 2 NM | 27 | 999.1 | 3.0 | 12.2 | 6 | 14.5 | 29 | 7 | 19.5 |
| VAN WARRIOR | LIBERIAN | 14 | 42.3 N | 178.5 E | 18 | 18 | 65 | .25 NM | 63 | 974.0 | 3.0 | 6.0 | | | | | |
| ALSTER EXPRESS | GERMAN | 14 | 38.8 N | 177.8 E | 18 | 29 | 52 | 5 NM | 02 | 998.0 | 6.3 | 12.0 | 5 | 24.3 | | | |
| ARCO JUNEAU | AMERICAN | 14 | 49.9 N | 135.8 W | 18 | 23 | 45 | 5 NM | 60 | 1000.3 | 3.6 | 3.0 | 5 | 10 | 27 | 8 | 18 |
| SEA FAN | SINGAPORE | 14 | 43.6 N | 159.2 W | 18 | 14 | N 48 | .5 NM | 20 | 997.0 | 6.0 | | | | | | |
| PACPRINCESS | LIBERIAN | 15 | 52.5 N | 140.4 W | 00 | 28 | N 56 | 2 NM | 58 | 989.5 | 6.0 | 5.0 | 8 | 23 | 28 | 8 | 26 |
| NORSK PILOT | BRITISH | 15 | 35.8 N | 174.5 E | 00 | 23 | 45 | 2 NM | 63 | 1000.6 | 11.9 | 7.5 | 4 | 13 | 34 | 12 | 18 |
| MOBIL ARCTIC | AMERICAN | 15 | 51.5 N | 137.0 W | 06 | 22 | 45 | 10 NM | 02 | 1010.0 | 5.0 | 9.5 | | 6.5 | 26 | 10 | 16.5 |
| VAN HAWK | LIBERIAN | 15 | 22.3 N | 121.4 E | 00 | 02 | 45 | 5 NM | 80 | 1018.0 | 20.0 | 21.0 | | | | | |
| WASHINGTON RAINBOW | JAPANESE | 15 | 53.2 N | 165.3 W | 00 | 28 | N 45 | 2 NM | 25 | 999.6 | 4.0 | 5.0 | 8 | 18 | | | |
| SAMUEL S | LIBERIAN | 15 | 40.2 N | 159.3 W | 00 | 24 | N 45 | .25 NM | | 991.5 | 14.0 | 9.0 | 9 | 11.5 | 21 | 7 | 11.5 |
| VAN WARRIOR | LIBERIAN | 15 | 42.5 N | 179.4 W | 00 | 26 | 70 | .25 NM | 72 | 981.0 | 4.5 | 5.0 | | | | | |
| NORSE PILOT | BRITISH | 16 | 34.4 N | 172.4 W | 18 | 19 | 45 | 10 NM | 63 | 999.6 | 19.1 | 5.5 | 2 | 6.5 | 21 | 12 | 16.5 |
| UNIVERSE KURE | LIBERIAN | 16 | 41.2 N | 179.1 W | 00 | 30 | N 48 | 5 NM | 85 | 999.8 | 2.0 | 8.5 | 8 | 16.5 | 29 | 8 | 21 |
| NORSE PILOT | BRITISH | 17 | 34.0 N | 170.7 W | 00 | 24 | 48 | 2 NM | 13 | 998.4 | 17.5 | 5.5 | 6 | 23 | | | |
| MOBIL MERIDIAN | AMERICAN | 17 | 58.7 N | 142.5 W | 12 | 13 | 45 | 10 NM | 81 | 994.6 | 5.0 | 6.1 | 6 | 10 | 11 | 9 | 14.5 |
| GREEN ECHO | LIBERIAN | 17 | 36.2 N | 147.0 E | 12 | 04 | N 48 | 1 NM | 63 | 1006.0 | 8.0 | 10.0 | 9 | 14.5 | | | |
| TAIWAN PHOENIX | SINGAPORE | 18 | 50.2 N | 144.5 W | 12 | 16 | N 45 | 1 NM | 65 | 972.0 | 6.5 | 9.0 | | 32.5 | | | |
| SEALIFT PACIFIC | AMERICAN | 18 | 56.7 N | 149.0 W | 12 | 10 | 45 | 2 NM | 63 | 973.6 | 2.2 | 3.3 | 7 | 11.5 | 20 | 12 | 16.5 |
| GREEN ECHO | LIBERIAN | 18 | 36.5 N | 149.1 E | 06 | 05 | N 42 | 1 NM | 61 | 1003.0 | 9.0 | 14.0 | 11 | 16.5 | | | |
| GREAT LAND | AMERICAN | 18 | 56.5 N | 142.8 W | 12 | 11 | N 50 | 1 NM | 21 | 984.2 | 4.4 | 7.6 | | | | | |
| ARCO JUNEAU | AMERICAN | 18 | 58.5 N | 146.1 W | 18 | 11 | N 63 | 2 NM | 21 | 976.7 | 4.0 | 0.0 | 8 | 26 | | | |
| CHEVRON HAWAII | AMERICAN | 18 | 56.6 N | 148.6 W | 18 | 09 | 45 | 1 NM | 63 | 968.5 | 3.3 | 2.8 | 5 | 13 | 14 | 10 | 16.5 |
| ZEALAND VENTURE | LIBERIAN | 18 | 53.4 N | 147.5 W | 18 | 23 | N 45 | 5 NM | 02 | 997.7 | 5.0 | 5.0 | 5 | 16.5 | 23 | 9 | 16.5 |
| MOBIL MERIDIAN | AMERICAN | 18 | 55.8 N | 138.1 W | 12 | 11 | 60 | 2 NM | 07 | 995.3 | 6.1 | 5.5 | | | 11 | 8 | 14.5 |
| MOBIL ARCTIC | AMERICAN | 18 | 59.2 N | 147.4 W | 18 | 07 | 60 | 2 NM | 65 | 980.0 | 3.0 | 3.3 | | | 11 | 8 | 14.5 |
| PRES KENNEDY | AMERICAN | 19 | 35.4 N | 194.6 E | 00 | 27 | 35 | 10 NM | 01 | 1001.0 | 14.4 | 14.4 | 7 | 10 | 27 | 7 | 32.5 |
| CHEVRON HAWAII | AMERICAN | 19 | 56.4 N | 148.2 W | 00 | 19 | 45 | 5 NM | 01 | 982.5 | 3.2 | 2.8 | 4 | 11.5 | 18 | 10 | 28 |
| ARCO JUNEAU | AMERICAN | 19 | 58.1 N | 145.5 W | 00 | 19 | N 48 | 2 NM | 51 | 982.0 | 3.9 | 0.0 | 8 | 23 | | | |
| MOBIL ARCTIC | AMERICAN | 19 | 58.5 N | 147.5 W | 06 | 14 | 50 | 2 NM | 56 | 993.0 | 4.0 | 3.3 | | | | | |
| PRESIDENT MADISON | AMERICAN | 19 | 35.7 N | 154.2 E | 00 | 25 | N 50 | 5 NM | 25 | 1004.2 | 12.2 | 17.2 | 9 | 14.5 | 14 | 10 | 26 |
| MOBIL MERIDIAN | AMERICAN | 19 | 52.0 N | 131.6 W | 18 | 17 | 45 | 2 NM | 80 | 1012.5 | 9.5 | 8.0 | 4 | 8 | 19 | 11 | 13 |
| MIEI MARU | JAPANESE | 20 | 40.0 N | 155.4 W | 18 | 25 | N 47 | 2 NM | 16 | 971.0 | 11.0 | 11.0 | 5 | 10 | 21 | 7 | 13 |
| HOLLAND MARU | JAPANESE | 20 | 43.6 N | 147.6 W | 18 | 14 | N 46 | 2 NM | 63 | 991.0 | 8.5 | 8.5 | 4 | 10 | 14 | 8 | 19.5 |
| VAN UNION | LIBERIAN | 20 | 42.2 N | 149.5 W | 18 | 16 | 61 | 1 NM | 18 | 980.5 | 11.5 | | 7 | 18 | | | |
| PRES TRUMAN | AMERICAN | 21 | 49.3 N | 146.9 W | 18 | 22 | 40 | 1 NM | 01 | 984.0 | 2.7 | 4.4 | 5 | 6.5 | 22 | 8 | 32.5 |
| HOLLAND MARU | JAPANESE | 21 | 43.5 N | 149.3 W | 00 | 16 | N 42 | 2 NM | 02 | 983.0 | 10.8 | 8.5 | 6 | 13 | 16 | 12 | 24.5 |
| VAN UNION | LIBERIAN | 21 | 42.3 N | 149.3 W | 00 | 19 | 44 | 1 NM | 18 | 979.0 | 12.0 | 8 | 19.5 | | | | |
| PRESIDENT MADISON | AMERICAN | 21 | 40.6 N | 178.7 E | 06 | 25 | N 45 | 10 NM | 03 | 996.0 | 8.3 | 10.0 | 8 | 26 | | | |
| PORTLAND | AMERICAN | 21 | 58.6 N | 150.2 W | 18 | 07 | 50 | 10 NM | 02 | 999.0 | 5.6 | 3.3 | 6 | 23 | 10 | 6 | 16.5 |
| NEWARK | AMERICAN | 21 | 56.7 N | 148.9 W | 18 | 08 | 56 | 5 NM | 61 | 988.0 | 2.8 | 4.4 | 6 | 21 | 07 | 10 | 19.5 |
| RICHARD | LIBERIAN | 22 | 14.0 N | 95.7 W | 18 | 05 | 42 | 5 NM | 03 | 1010.2 | 21.0 | 28.3 | 3 | 11.5 | | | |
| PRES TRUMAN | AMERICAN | 22 | 49.9 N | 148.6 W | 00 | 21 | 55 | 5 NM | 27 | 991.0 | 2.2 | 3.9 | 8 | 10 | 22 | 8 | 32.5 |
| SANTA CLARA | AMERICAN | 22 | 57.8 N | 149.4 W | 00 | 09 | 45 | .5 NM | 45 | 983.1 | 3.3 | 4.4 | 6 | 24.5 | | | |
| GLACIER BAY | AMERICAN | 22 | 59.6 N | 144.9 W | 00 | 08 | 45 | 10 NM | 02 | 999.5 | 6.2 | 2.7 | 12 | 16.5 | | | |
| GREEN ECHO | LIBERIAN | 22 | 43.2 N | 171.5 E | 00 | 12 | N 50 | 200 YD | 84 | 990.0 | 3.0 | 5.0 | 10 | 16.5 | | | |
| ZIM TOKYO | GERMAN | 22 | 13.8 N | 95.6 W | 03 | 04 | 53 | 2 NM | 02 | 1013.2 | 23.2 | 26.7 | 12 | 28 | | | |
| FALSTRIA | DANISH | 22 | 14.4 N | 98.3 W | 00 | 06 | N 44 | 10 NM | 03 | 1012.0 | 28.2 | | 6 | 10 | | | |
| MELLON | AMERICAN | 22 | 43.4 N | 157.9 W | 06 | 17 | N 55 | 5 NM | 02 | 984.0 | 7.2 | 8.0 | 6 | 11.5 | | | |
| NORBU | LIBERIAN | 22 | 44.6 N | 179.0 W | 12 | 16 | 47 | 5 NM | 70 | 984.0 | 5.0 | 2.0 | 8 | 13 | | | |
| PRES JEFFERSON | AMERICAN | 22 | 54.0 N | 148.4 W | 12 | 22 | 48 | 50 YD | | 990.3 | 2.2 | 1.6 | 7 | 24.5 | 22 | 9 | 32.5 |
| PHILADELPHIA | AMERICAN | 22 | 58.4 N | 148.6 W | 18 | 17 | 50 | 2 NM | 63 | 999.7 | 2.7 | 4.4 | 7 | 36 | 18 | 8 | 41 |

| Vessel | Nationality | Date | Position of Ship Lat. deg. | Position of Ship Long. deg. | Time GMT | Wind Dir. 10° | Wind Speed kt. | Visibility n. mi. | Present Weather code | Pressure mb. | Temperature °C Air | Temperature °C Sea | Sea Waves* Period sec. | Sea Waves* Height ft. | Swell Waves Dir. 10° | Swell Waves Period sec. | Swell Waves Height ft. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NORTH PACIFIC OCEAN | | FEB. | | | | | | | | | | | | | | | |
| NEWARK | AMERICAN | 22 | 56.5 N | 148.6 W | 00 | 08 | 55 | 4 NM | 63 | 978.0 | 2.8 | 4.5 | 6 | 19.5 | | | |
| PORTLAND | AMERICAN | 22 | 57.9 N | 148.0 W | 12 | 11 | 47 | 5 NM | 02 | 992.5 | 3.8 | 4.5 | 7 | 23 | | | |
| AMER CORSAIR | AMERICAN | 23 | 33.8 N | 144.7 E | 06 | 27 | 45 | 10 NM | 01 | 1001.7 | 13.9 | 17.2 | 5 | 19.5 | | | |
| SHINWIND | LIBERIAN | 24 | 41.2 N | 178.7 E | 12 | 09 | M 42 | 2 NM | 63 | 985.0 | 5.0 | 9.0 | 6 | 11.5 | 10 | | 23 |
| UNITED SPIRIT | LIBERIAN | 24 | 35.9 N | 146.7 E | 00 | 32 | M 45 | 5 NM | 80 | 1015.0 | 6.0 | 10.0 | 10 | 19.5 | | | |
| SHUNWIND | LIBERIAN | 25 | 42.0 N | 176.8 W | 09 | 28 | M 36 | 2 NM | 07 | 982.0 | 5.0 | 8.0 | 7 | 19.5 | 28 | 8 | 32.5 |
| SEALIFT PACIFIC | AMERICAN | 25 | 48.1 N | 173.7 W | 12 | 07 | 50 | 5 NM | 02 | 986.5 | 2.7 | 2.2 | 6 | 19.5 | | | |
| ARCO PRUDHOE BAY | AMERICAN | 25 | 56.6 N | 150.5 W | 06 | 10 | 45 | 10 NM | 01 | 1001.4 | 6.8 | 3.8 | XX | 14.5 | 13 | 9 | 29.5 |
| GREEN ECHO | LIBERIAN | 25 | 49.3 N | 159.5 W | 18 | 14 | M 45 | .5 NM | 50 | 994.0 | 6.5 | 3.0 | 12 | 19.5 | | | |
| NORDU | LIBERIAN | 26 | 48.4 N | 147.1 W | 18 | 11 | 41 | 2 NM | 60 | 1002.0 | 8.0 | 1.0 | 9 | 14.5 | 15 | 8 | 8 |
| SEALIFT PACIFIC | AMERICAN | 26 | 46.8 N | 172.3 W | 02 | 27 | 60 | 5 NM | 60 | 970.2 | 3.4 | 2.3 | 6 | 24.5 | 29 | 12 | 24.5 |
| GREEN ECHO | LIBERIAN | 26 | 49.4 N | 158.0 W | 00 | 12 | N 45 | 50 YD | 53 | 993.0 | 7.0 | 3.0 | 8 | 16.5 | | | |
| NEW ENGLAND HUNTER | LIBERIAN | 27 | 27.9 N | 144.4 W | 12 | 31 | 55 | 2 NM | 02 | 1008.0 | 14.7 | 19.0 | 4 | 8 | | | |
| ANDERS MAERSK | DANISH | 27 | 34.0 N | 178.5 E | 06 | 31 | 60 | 1 NM | | 998.5 | 12.0 | | 9 | 36 | | | |
| AMER ACCORD | AMERICAN | 27 | 34.8 N | 173.6 E | 09 | 30 | 40 | 5 NM | 25 | 1005.0 | 8.3 | 12.2 | 8 | 28 | | | |
| SEALIFT PACIFIC | AMERICAN | 27 | 39.8 N | 166.0 W | 21 | 27 | 60 | 2 NM | 81 | 980.5 | 10.0 | 8.9 | 10 | 28 | | | |
| NORTHERLY TRADER | LIBERIAN | 28 | 40.0 N | 160.2 W | 00 | 28 | M 45 | .25 NM | 05 | 978.3 | 9.0 | 9.0 | 6 | 6.5 | 28 | >13 | 23 |
| PRES JOHNSON | AMERICAN | 28 | 43.8 N | 170.5 W | 00 | 31 | 50 | 1 NM | 75 | 970.0 | 1.7 | 5.0 | 8 | 11.5 | 31 | 8 | 26 |
| SEALAND COMMERCE | AMERICAN | 28 | 48.7 N | 165.6 W | 12 | 12 | 50 | 1 NM | 63 | 975.5 | 5.0 | 3.3 | 12 | 29.5 | | | |
| SEALIFT PACIFIC | AMERICAN | 28 | 39.7 N | 145.7 W | 00 | 27 | 70 | 2 NM | 01 | 985.4 | 9.5 | 8.9 | 10 | 41 | | | |
| PRES ROOSEVELT | AMERICAN | 28 | 39.2 N | 140.2 E | 18 | 15 | 50 | 5 NM | 81 | 993.0 | 11.7 | 11.7 | 4 | 10 | 15 | 6 | 19.5 |
| ENVIRONMENTAL BUOYS | | | | | | | | | | | | | | | | | |
| 46001 | AMERICAN | 18 | 56.0 N | 147.9 W | 09 | 09 | M 41 | | | 976.8 | 1.8 | 3.0 | 9 | 16.5 | | | |
| 46001 | AMERICAN | 21 | 56.0 N | 147.9 W | 18 | 08 | M 43 | | | 984.4 | 2.9 | 3.1 | 9 | 19.5 | | | |
| 46001 | AMERICAN | 22 | 56.0 N | 147.9 W | 09 | 15 | M 43 | | | 988.2 | 1.7 | 3.0 | 11 | 23 | | | |
| 46003 | AMERICAN | 22 | 52.0 N | 155.0 W | 03 | 25 | M 43 | | | 970.6 | 1.8 | 3.0 | 9 | 19.5 | | | |
| 46003 | AMERICAN | 24 | 52.0 N | 156.0 W | 21 | 15 | M 42 | | | 980.5 | 2.7 | 3.0 | 9 | 18 | | | |
| 46003 | AMERICAN | 25 | 52.0 N | 156.0 W | 00 | 22 | M 42 | | | 985.6 | 2.4 | 3.0 | 11 | 23 | | | |
| 46008 | AMERICAN | 21 | 57.1 N | 151.7 W | 21 | 07 | M 42 | | | 984.2 | 2.7 | 4.4 | 9 | 23 | | | |

\+ Direction for sea waves same as wind direction
X Direction or period of waves indeterminate
M Measured wind

NOTE: The observations are selected from those with winds ≥ 35 kn or waves ≥ 25 ft from May through August (≥ 41 kn or ≥ 33 ft, September through April). In cases where a ship reported more than one observation a day with such values, the one with the highest wind speed was selected.

Continued from page 294.

JANUARY — DATA SUMMARY — 46006

AVERAGE LATITUDE 41.1N — AVERAGE LONGITUDE 137.8W

MEANS AND EXTREMES

| | MIN | (DA HR) | MEAN | MAX | (DA HR) | NO. OF OBS | DAYS WITH DATA |
|---|---|---|---|---|---|---|---|
| AIR TEMP (DEG C) | 08.6 | (20 21) | 11.7 | 14.4 | (08 08) | 248 | 31 |
| PRESSURE (MBAR) | 0978.7 | (14 12) | 1004.8 | 1028.8 | (25 08) | 246 | 31 |

WIND - % FREQUENCIES, MEANS AND EXTREMES

| | SPEED (KNOTS) 1- | 11- | 22- | 34- | MEAN SPEED (KNOTS) | NO. OF OBS: 248 |
|---|---|---|---|---|---|---|
| DIR | <4 | 10 | 21 | 33 | 47 | >47 | % | |
| N | .4 | 1.6 | .8 | | | 2.8 | 3.6 | MAX WIND |
| NE | | 2.2 | | | | 1.2 | 5.7 | SPEED: 38 KNOTS |
| E | | .4 | 2.4 | 1.2 | | 4.1 | 18.5 | DIRECTION: 280 DEG |
| SE | | .4 | 4.8 | 2.4 | 1.2 | 8.9 | 21.9 | DAY: 08 |
| S | | 1.2 | 11.4 | 12.5 | 1.6 | 26.8 | 21.6 | HOUR: 19 |
| SW | .4 | 1.2 | 15.8 | 5.3 | | 22.8 | 18.1 | |
| W | | 1.6 | 11.0 | 15.4 | 1.2 | 29.3 | 22.4 | |
| NW | | | 2.0 | 1.6 | .4 | 4.1 | 25.0 | |
| CALM | | | | | | | | |
| TOTAL | .8 | 7.7 | 48.4 | 38.6 | 4.5 | 100.0 | 20.6 | |

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 243

| HEIGHT (M) | <1 | 1-1.5 | 2-2.5 | 3-3.5 | 4-5.5 | 6-7.5 | 8-9.5 | >9.5 | MEAN | MAX | (DA HR) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| % FREQUENCY | | | 11.5 | 45.7 | 38.8 | 2.9 | .4 | | 3.7M | 8.0M | (18 21) |

JANUARY — DATA SUMMARY — 46008

AVERAGE LATITUDE 57.1N — AVERAGE LONGITUDE 151.7W

MEANS AND EXTREMES

| | MIN | (DA HR) | MEAN | MAX | (DA HR) | NO. OF OBS | DAYS WITH DATA |
|---|---|---|---|---|---|---|---|
| AIR TEMP (DEG C) | 00.1 | (09 06) | 03.6 | 05.2 | (14 08) | 238 | 31 |
| SEA TEMP (DEG C) | 03.9 | (02 09) | 04.4 | 05.2 | (10 09) | 238 | 31 |
| AIR-SEA TEMP (DEG C) | -04.3 | (05 18) | -00.8 | 01.0 | (09 08) | 238 | 31 |
| PRESSURE (MBAR) | 0972.5 | (08 18) | 1004.5 | 1027.2 | (01 21) | 239 | 31 |

WIND - % FREQUENCIES, MEANS AND EXTREMES

| | SPEED (KNOTS) 1- | 11- | 22- | 34- | MEAN SPEED (KNOTS) | NO. OF OBS: 235 |
|---|---|---|---|---|---|---|
| DIR | <4 | 10 | 21 | 33 | 47 | >47 | % | |
| N | .9 | 2.1 | 2.1 | | | 4.7 | 11.2 | MAX WIND |
| NE | .4 | 2.1 | 7.2 | 5.1 | .9 | 15.7 | 18.5 | SPEED: 38 KNOTS |
| E | .4 | 4.3 | 26.0 | 19.7 | .4 | 48.9 | 18.8 | DIRECTION: 090 DEG |
| SE | .9 | 2.1 | 10.2 | 5.1 | | 18.3 | 15.9 | DAY: 08 |
| S | .9 | 1.3 | 2.6 | | | 4.7 | 10.6 | HOUR: 08 |
| SW | .9 | .9 | 3.4 | .4 | | 5.7 | 15.0 | |
| W | .4 | .9 | 1.3 | | | 2.6 | 11.4 | |
| NW | .9 | 1.3 | .4 | | | 2.6 | 7.7 | |
| CALM | | | | | | | | |
| TOTAL | 4.7 | 14.5 | 53.2 | 28.4 | 1.3 | 100.0 | 18.8 | |

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 223

| HEIGHT (M) | <1 | 1-1.5 | 2-2.5 | 3-3.5 | 4-5.5 | 6-7.5 | 8-9.5 | >9.5 | MEAN | MAX | (DA HR) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| % FREQUENCY | | 1.8 | 14.8 | 50.7 | 17.5 | 15.1 | | | 2.7M | 6.5M | (08 12) |

JANUARY — DATA SUMMARY — 46080

AVERAGE LATITUDE 60.3N — AVERAGE LONGITUDE 140.9W

MEANS AND EXTREMES

| | MIN | (DA HR) | MEAN | MAX | (DA HR) | NO. OF OBS | DAYS WITH DATA |
|---|---|---|---|---|---|---|---|
| AIR TEMP (DEG C) | -02.3 | (08 06) | 02.6 | 05.1 | (24 21) | 218 | 31 |
| SEA TEMP (DEG C) | 02.3 | (02 03) | 04.0 | 05.3 | (24 21) | 213 | 31 |
| AIR-SEA TEMP (DEG C) | -06.5 | (08 06) | -01.4 | 02.0 | (09 10) | 212 | 31 |
| PRESSURE (MBAR) | 0988.3 | (24 09) | 1011.2 | 1032.8 | (01 18) | 214 | 31 |

WIND - % FREQUENCIES, MEANS AND EXTREMES

| | SPEED (KNOTS) 1- | 11- | 22- | 34- | MEAN SPEED (KNOTS) | NO. OF OBS: 212 |
|---|---|---|---|---|---|---|
| DIR | <4 | 10 | 21 | 33 | 47 | >47 | % | |
| N | 1.4 | 8.0 | 1.9 | | | 6.9 | 7.1 | MAX WIND |
| NE | 3.3 | 12.3 | 21.2 | 2.8 | | 39.6 | 12.3 | SPEED: 27 KNOTS |
| E | .9 | 8.5 | 14.6 | 3.8 | | 27.8 | 14.2 | DIRECTION: 080 DEG |
| SE | .9 | 1.9 | 1.4 | | | 4.2 | 7.7 | DAY: 23 |
| S | .5 | 3.3 | .5 | | | 4.2 | 5.9 | HOUR: 12 |
| SW | .5 | | | | | .5 | 3.0 | |
| W | .5 | .9 | .5 | | | 1.9 | 7.3 | |
| NW | 1.9 | 8.0 | 1.9 | | | 11.8 | 7.2 | |
| CALM | | | | | | | | |
| TOTAL | 9.8 | 41.9 | 42.0 | 6.6 | | 100.0 | 11.1 | |

FEBRUARY — DATA SUMMARY — 46006

AVERAGE LATITUDE 41.1N — AVERAGE LONGITUDE 137.8W

MEANS AND EXTREMES

| | MIN | (DA HR) | MEAN | MAX | (DA HR) | NO. OF OBS | DAYS WITH DATA |
|---|---|---|---|---|---|---|---|
| AIR TEMP (DEG C) | 03.8 | (08 19) | 10.5 | 15.8 | (19 03) | 223 | 28 |
| PRESSURE (MBAR) | 0981.0 | (09 00) | 1009.3 | 1026.2 | (19 08) | 223 | 28 |

WIND - % FREQUENCIES, MEANS AND EXTREMES

| | SPEED (KNOTS) 1- | 11- | 22- | 34- | MEAN SPEED (KNOTS) | NO. OF OBS: 223 |
|---|---|---|---|---|---|---|
| DIR | <4 | 10 | 21 | 33 | 47 | >47 | % | |
| N | | 1.3 | 4.0 | .4 | | | 5.8 | 13.3 | MAX WIND |
| NE | | | 1.2 | .4 | | | 1.6 | 5.1 | SPEED: 38 KNOTS |
| E | | .4 | 3.1 | 3.2 | | | 6.8 | 19.8 | DIRECTION: 310 DEG |
| SE | | 1.8 | 4.9 | 4.5 | | | 11.2 | 18.5 | DAY: 12 |
| S | | .4 | .9 | 15.5 | 1.3 | | 23.0 | 23.0 | HOUR: 19 |
| SW | | | .4 | 9.8 | 11.7 | | 22.0 | 20.0 | |
| W | | | .4 | 5.4 | 12.7 | .9 | 19.4 | 23.4 | |
| NW | | | .4 | 4.0 | 4.0 | 1.3 | 9.9 | 24.2 | |
| CALM | | | | | | | | | |
| TOTAL | | .4 | 5.8 | 41.3 | 48.9 | 3.6 | 100.0 | 21.0 | |

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 222

| HEIGHT (M) | <1 | 1-1.5 | 2-2.5 | 3-3.5 | 4-5.5 | 6-7.5 | 8-9.5 | >9.5 | MEAN | MAX | (DA HR) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| % FREQUENCY | | | 14.4 | 37.8 | 41.4 | 5.8 | .5 | | 3.6M | 8.0M | (12 08) |

FEBRUARY — DATA SUMMARY — 46008

AVERAGE LATITUDE 57.1N — AVERAGE LONGITUDE 151.7W

MEANS AND EXTREMES

| | MIN | (DA HR) | MEAN | MAX | (DA HR) | NO. OF OBS | DAYS WITH DATA |
|---|---|---|---|---|---|---|---|
| AIR TEMP (DEG C) | -00.2 | (08 08) | 01.8 | 04.9 | (23 08) | 217 | 28 |
| SEA TEMP (DEG C) | 03.7 | (14 15) | 04.2 | 04.8 | (22 12) | 215 | 28 |
| AIR-SEA TEMP (DEG C) | -04.7 | (08 15) | -02.4 | 00.8 | (23 08) | 215 | 28 |
| PRESSURE (MBAR) | 0958.0 | (06 00) | 0984.9 | 1020.7 | (26 08) | 217 | 28 |

WIND - % FREQUENCIES, MEANS AND EXTREMES

| | SPEED (KNOTS) 1- | 11- | 22- | 34- | MEAN SPEED (KNOTS) | NO. OF OBS: 213 |
|---|---|---|---|---|---|---|
| DIR | <4 | 10 | 21 | 33 | 47 | >47 | % | |
| N | .5 | 2.3 | 6.6 | .5 | | | 9.9 | 13.6 | MAX WIND |
| NE | .5 | .9 | 1.4 | 1.4 | | | 4.2 | 21.8 | SPEED: 42 KNOTS |
| E | | 3.9 | 14.1 | 14.6 | 2.8 | | 35.2 | 21.2 | DIRECTION: 070 DEG |
| SE | .5 | 3.8 | 8.0 | 11.7 | .9 | | 24.9 | 20.2 | DAY: 21 |
| S | .5 | 2.8 | 5.2 | 4.2 | .5 | | 13.1 | 18.2 | HOUR: 21 |
| SW | .5 | .5 | 2.3 | | | | 3.3 | 13.5 | |
| W | .9 | .5 | | | | | 1.4 | 4.0 | |
| NW | | 1.4 | 3.3 | 1.4 | | | 6.1 | 16.9 | |
| CALM | .9 | | | | | | .9 | | |
| TOTAL | 4.2 | 16.0 | 40.4 | 33.8 | 9.6 | | 100.0 | 18.8 | |

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 200

| HEIGHT (M) | <1 | 1-1.5 | 2-2.5 | 3-3.5 | 4-5.5 | 6-7.5 | 8-9.5 | >9.5 | MEAN | MAX | (DA HR) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| % FREQUENCY | | | 7.5 | 28.5 | 36.0 | 33.5 | 5.0 | .5 | 3.5M | 8.9M | (22 00) |

% OF OBS WITH POTENTIAL SUPERSTRUCTURE ICING: MODERATE: 0.0% SEVERE: NONE #OBS: 213

FEBRUARY — DATA SUMMARY — 46080

AVERAGE LATITUDE 60.3N — AVERAGE LONGITUDE 146.8W

MEANS AND EXTREMES

| | MIN | (DA HR) | MEAN | MAX | (DA HR) | NO. OF OBS | DAYS WITH DATA |
|---|---|---|---|---|---|---|---|
| AIR TEMP (DEG C) | -01.4 | (04 15) | 02.5 | 05.1 | (15 05) | 200 | 28 |
| SEA TEMP (DEG C) | 02.7 | (04 08) | 04.1 | 04.8 | (23 18) | 197 | 28 |
| AIR-SEA TEMP (DEG C) | -04.7 | (08 12) | -01.5 | 03.6 | (15 19) | 197 | 28 |
| PRESSURE (MBAR) | 0982.4 | (08 03) | 1003.0 | 1027.8 | (27 21) | 200 | 28 |

WIND - % FREQUENCIES, MEANS AND EXTREMES

| | SPEED (KNOTS) 1- | 11- | 22- | 34- | MEAN SPEED (KNOTS) | NO. OF OBS: 188 |
|---|---|---|---|---|---|---|
| DIR | <4 | 10 | 21 | 33 | 47 | >47 | % | |
| N | | | | | | | 10.7 | 8.6 | MAX WIND |
| NE | 3.1 | 5.6 | 2.0 | | | | 10.1 | 18.0 | SPEED: 28 KNOTS |
| E | 1.0 | 5.6 | 17.9 | 5.6 | | | 32.7 | 18.5 | DIRECTION: 080 DEG |
| SE | 1.5 | 5.1 | 16.3 | 9.7 | | | 32.2 | 14.5 | DAY: 13 |
| S | | 2.0 | 9.2 | | | | 11.2 | 11.5 | HOUR: 08 |
| SW | | | 2.6 | 2.6 | | | 5.1 | 7.0 | |
| W | | .5 | | | | | .5 | 1.0 | |
| NW | .5 | | | | | | .5 | 7.0 | |
| CALM | .5 | 5.6 | 3.0 | | | | 9.1 | 7.9 | |
| TOTAL | 7.1 | 27.0 | 50.9 | 19.3 | | | 100.0 | 13.8 | |

# Rough Log, North Atlantic Weather

## April and May 1978

ROUGH LOG, APRIL 1978--The paths of the storm centers were clustered in the vicinity of Newfoundland. They passed over or near the island in almost every direction, except south. The most-traveled path was from the northern Midwest, across the Great Lakes to New Brunswick, and then from Newfoundland to east of Kap Farvel. There was one lucky location near Quebec where the paths of four storms crossed. There were fewer storms than normal along the U.S. East Coast. Three storms wandered over Scandinavia. There were several storms that approached the west coast of Europe with only two centers penetrating any distance inland. Four storms influenced the central Mediterranean Sea.

The concentration of storm paths near Newfoundland was reflected in the monthly mean-pressure pattern. The Icelandic Low was shifted from east of Kap Farvel to two 1007-mb centers, one near Trinity Bay, Newfoundland, and the other near 50°N, 47°W. This was only 1 mb deeper than the climatic mean. The Azores High was 1024 mb near 30°N, 28°W, a few miles east of its climatic normal 1021-mb center.

There were two significant anomaly centers. A negative 5 mb was just south of St. Pierre Island, and a positive 11-mb center was slightly east of Iceland.

In the upper air there was an anomalous LOW over Belle Isle with a pronounced ridge over Iceland and west of the United Kingdom.

Extratropical Cyclones--This first storm of the month moved eastward out of the northern Plains States. At 1200 on the 2d the 990-mb center was over Cape Breton Island. The AMERICAN ARCHER was near 39°N, 63°W, ahead of the cold front with southerly 40-kn winds and 25-ft swells. A ship with the call letters YNTF reported howling 70-kn winds at the cold front near 38°N, 70°W. Six hours later the GENERAL STANISLAW POPLAW was pounded by 30-ft seas and swells about 400 mi south of St. John's. On the 3d the winds were generally 40 to 50 kn, but the ATLANTIC CINDERELLA found 70-kn winds just ahead of the trough behind the front (fig. 74). Ships were reporting 20- to 26-ft waves. At 1200 on the 4th the storm was over the southern tip of Greenland and doomed.

Figure 74.--The cumulus-type cloud streets curve to fit the wind in the trough behind the front. This cloud pattern indicates very unstable air.

This storm formed late on the 3d as a frontal wave on the front trailing from the storm above. It raced north-northeastward and continued to pull cold air southward. The winds west of the front were generally gales and the swell was from the northwest at 10 to 15 ft. East of the front the winds were a little stronger. The HENRI POINCARE (42°N, 37°W) had 50-kn winds from the southeast. Near 45°N, 38°W, the ATLANTIC CROWN was carrying 44-kn winds and 25-ft swells. A ship far to the south near 33°N, 43°W, also was grappling with 25-ft swells.

This LOW, now at 984 mb, was slightly east of Kap Farvel at 1200 on the 5th. The strongest winds were 40 kn or less with occasional 20-ft waves. The storm drifted up the Greenland coast and disappeared in the Denmark Strait on the 8th.

A low center developed off Norfolk on the 7th. It moved northeastward and turned northward and then westward on the 9th. The AMERICAN LEGEND had 45-kn winds and 21-ft seas and swells slapping her starboard side near the occlusion on the 8th. As this LOW languished over Newfoundland on the 10th, several small LOWs spun out of the trough south of the LOW. A 1036-mb HIGH was moving southeastward from Greenland and blocking eastward movement of the front and these LOWs. The HIGH was pushing relentlessly southward as the LOWs wore themselves out against its western edge. The gradient tightened between the front and the HIGH. The AKADEMIK FILATOV (41°N, 36°W) was sailing northeastward east of the front with 50-kn winds and 23-ft waves. On the 13th a SHIP at the front was sailing eastward with 36-ft swells on her stern. By the 13th another LOW was moving northeastward from the East Coast and changed the orientation of the gradient as the HIGH moved southeastward.

This LOW came out of the high plains of Canada west of Lake Winnipeg. Its center moved off the coast over Nova Scotia on the 14th. Another LOW was paving its way. The AMERICAN ARCHER was east of this LOW with 62-kn southeasterly winds. The westerly circulation south of the centers extended nearly coast to coast.

At 1200 on the 15th the LOW of interest was 976 mb near 45°N, 47°W (fig. 75). The EXPORT DIPLOMAT at 36.5°N, 55°W, had 45-kn winds and 23-ft waves. The HANS SACHS was at 39°N, 44°W, at 1800

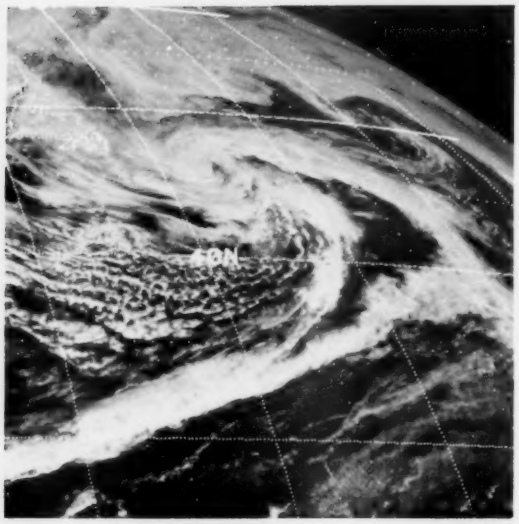


Figure 75.--The LOW has moved to 47°N, 47°W, by 1700, the time of this image. The HANS SACHS was under scattered clouds slightly west of the front.

with 60-kn westerlies and 33-ft seas. On the 16th there was only one 968-mb LOW near 52°N, 34°W. The AMERICAN ARCHER was near 46°N, 39°W (about 400 mi southwest of the center) and stationary with 50-kn westerly winds, 20-ft seas, and 49-ft swells. At 1800 the observation was the same, except the wind and swell direction backed 10 degrees. The SUGAR CRYSTAL was about 10° longitude farther east with 30-ft swells, which continued into the 17th. The LOW had now turned northwestward. Two ships between Iceland and Scotland both reported 58-kn southeasterly winds. As the LOW approached Kap Farvel on the 18th, it broke away from the upper air circulation and again moved eastward to dissipate south of Iceland.

As the above LOW moved northward, high pressure was moving southeastward out of Canada. On the 18th the HIGH split into multiple centers creating a large area of flat gradient off the East Coast. Cyclonic circulation developed between three HIGH centers on the 18th. This LOW was very clearly defined by the wind and pressure reports of three ships almost evenly spaced around the inceptive center. By the 19th it had formed a concentrated circulation, and a ship reported 40-kn northeasterlies. At this time another center formed east of the first. Several ships were reporting gale-force winds. On the 20th a ship northeast of the center had 20-ft waves, as did another southwest of the center.

On the 21st the LOW was 990 mb near 46°N, 31°W. The ORBITA was not far away with 60-kn westerly winds. The EXPORT PATRIOT had 45-kn winds and 15-ft waves pounding her beam as she sailed toward the English Channel. OWS Romeo recorded 20-ft waves which increased to 23 ft by the 22d. At that time the LOW stalled near 55°N, 23°W, for 18 hr before turning southward then southeastward to dissipate over the Bay of Biscay on the 27th.

This East Coast LOW formed on the 20th at the point of occlusion of a frontal system moving eastward out of the Midwest. There was an isolated 40-kn wind report that afternoon. By 1200 on the 21st the 992-mb storm was slightly north of Maine. An English ship was sailing toward New York with southerly 40-kn winds and 26-ft swells hitting her port side. The MORMACSTAR was also heading toward New York at 37.5°N, 63°W, with 45-kn winds and 16-ft waves.

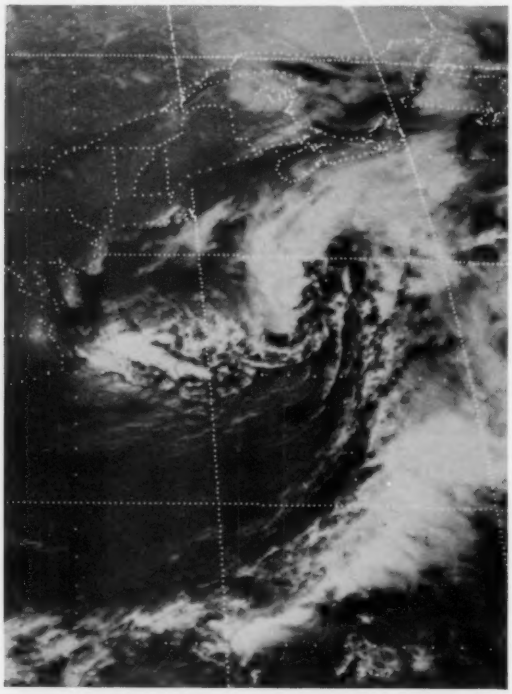


Figure 76.--The storm was off Long Island by 1700. Winds of 80 kn were reported an hour after this image.

On the 22d another LOW formed off Cape Hatteras (fig. 76). At 1200 the ROMANTIC was southwest of the center near 37°N, 70°W, and radioed winds of 98 kn. This seemed high, but 6 hr later the ALBATROSS 4 also sent a report of 80-kn winds from near 41°N, 66°W, with 16-ft seas and 43-ft swells. Their relationship to the storm's center was very near the same.

On the 23d the second LOW became the primary storm. The storm center moved over Newfoundland on the 24th. The EXPORT BAY was sailing with 23-ft swells on her stern on the 25th. The ROBERT E. LEE (40°N, 60°W) was north of the Mason-Dixon Line with 58-kn northwesterly winds. Late that day the LOW disappeared and another formed nearby and moved toward the Labrador Sea to fade away.

Monster of the Month--This storm traveled southeastward out of the northern plains. As it crossed the Carolinas on the 26th, it dumped heavy rain over a large area of the central East Coast. Gale warnings were in effect from Cape Hatteras northward, and tides were expected to be 1 to 2 ft above normal and cause additional beach erosion. By late on the 26th the storm had produced 1 to 3 in of rain in many areas, with 4 to 6 in in parts of North Carolina. Rivers were flooding. In the Norfolk area, the winds gusted to 48 kn and to 60 kn in Hampton, Va. High tides and surf were 3 ft above normal, with flooding causing much erosion (fig. 77). Over 6 in of rain fell in the Roanoke, Va., area and up to 21 in of snow fell in the southwestern mountains. A barge on the Chesapeake Bay broke its moorings and crashed into the Pamunkey River bridge knocking out two pilings.

The 0000 chart of the 27th showed the storm over Cape Hatteras at 998 mb. At that time the CHEVRON ARNHEM was off Norfolk with 58-kn winds out of the east and 30-ft seas. Six hours earlier the winds had been 44 kn and the seas 26 ft (fig. 78). At 1800 the

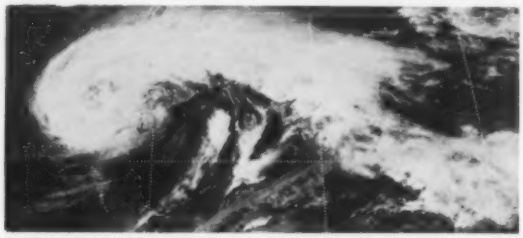


Figure 78.--This satellite image was for 1700 on the 26th. The surface center is over North Carolina. The cloud center over Georgia is in the high-level circulation.

Figure 77.--This oil truck fell through the pavement when it was undercut by the high water. Wide World Photo.

SAN JUAN was west of the center with 45-kn gales and 20-ft seas.

At 0000 on the 28th the 990-mb LOW was near 38°N, 71°W. The SANTA LUCIA was 180 mi due west of the center. The northerly winds were 50 kn with 20-ft seas, but the swells were a towering 41 ft. The MARIA U was only 4 mb west of the center with 63-kn winds and waves of 30 ft. Twenty-four hours later at 0000 on the 29th, the storm was 980 mb. The LEON PIERRE had 45-kn winds and 25-ft waves slightly over 300 mi south of the center. At 1200 the BEN OCEAN LANCER at 43°N, 62°W, within 10 mb of the center had 45-kn northerly winds, 25-ft seas, and 30-ft swells. Many of the wind reports were running in the gale category, but the sea reports of 20 ft or greater were increasing south of the center as the fetch increased.

The storm center moved over Cape Race on the 30th. A reporter called VC94 had 61-kn southerly winds in the vicinity of 47°N, 46°W. Far to the south a ship had 26-ft swell waves. Late on the 30th another LOW formed over the Gaspe Peninsula to the west. Within 12 hr the original LOW had disappeared.

Casualties--The 19,664-ton FEDERAL THAMES and the 6,017-ton CABOT collided during a snow storm on the 1st about 20 mi upriver from Quebec City. The 13,203-ton SATURN had tank damage due to ice pressure in Lake Michigan. The 76,088-ton THALASSINI DOXA put into Gibraltar on the 9th because of reported ice damage. The 35,302-ton bulkcarrier HOPECLIPPER arrived Leningrad behind an icebreaker convoy with a cracked bow. The 16,023-ton ROSELINE collided with the 12,680-ton ELENI V on the 6th. The ELENI V was cut in half in fog with 1 mi visibility. All crewmembers were safe.

The 5,924-ton ARSENE SIMARD was in dyydock on the 14th at Lauzon, Quebec, with ice damage. The sistership JOS. SIMARD (5,102 tons) was at Montreal with ice damage the same day. The platform ORION onboard pontoon FEDERAL 400-5 from Cherbourg to Recife was hove-to for 5 hr in southerly winds of force 8/9 (gale to strong gale) with rough seas and heavy swells.

An iceberg 36 times the area of Bermuda and inhabited by penguins is drifting slowly in the South Atlantic from Antarctica in the direction of Africa. It measures 32 by 24 mi with a draft of at least 600 ft. The first week of May it was about 200 mi northwest of South Georgia Island.

ROUGH LOG, MAY 1978--There was little rhyme or reason to the storm tracks this month. Those over and off the U.S. East Coast traced paths like a drunken sailor. Many storms looped and turned along their tracks. The only path that had a similarity to climatology was from southeast of Newfoundland into the Denmark Strait. Two storms from the Atlantic and one that moved southward across England entered the continent of Europe.

The main feature in the pressure pattern was the large Azores High at 1025 mb centered near 32°N, 38°W. It was 3 mb higher than and near its climatic position. The Icelandic Low was 1008 mb near 63°N, 30°W versus the climatic value of 1012 mb near 55°N, 37°W. A tongue of high pressure stretched down into Canada from near the North Pole. There was an anomalous high-pressure center near Scandinavia.

The large anomaly centers were all north of latitude 60°N. There was a positive 8-mb center over the Gulf of Bothnia and a positive 4-mb center over Hudson Bay. Greenland was surrounded by a negative 4-mb anomaly isoline with two minus 6-mb centers. One was over the central Ice Cap and the other south of the Denmark Strait. In the central Atlantic there were three spots with positive 4-mb anomaly values.

The upper air mean pattern differed radically from climatology at 700 mb. The trough that normally parallels the northeastern Canadian coast was shifted eastward to over Baffin Bay and east of Newfoundland. The trough then broke and was near its normal position off the U.S. East Coast. The anomalous surface HIGH over Scandinavia was reflected at 700 mb.

There were no tropical cyclones during May. June 1 marked the beginning of the season in the Atlantic. Over the past 30 yr the average number of named storms has been nine, six of which were hurricanes. An average of three storms cross the U.S. Coast, and one is a hurricane. The names were published in the May issue.

Extratropical Cyclones--May was a fairly quiet month with no extremely violent storms. The first storm formed as a frontal wave and was first analyzed on the 1200 chart of the 2d. There was an indication on the 0000 chart, when the LASH ATLANTICO reported a thunderstorm. On the 1200 chart a SHIP near the cold front (41°N, 55°W) had 25-ft swells on her stern. Only a few miles to the east the JADRO had 44-kn southerly winds and 20-ft waves. By 1200 on the 3d, the 986-mb LOW was near 55°N, 50°W, and starting a cyclonic loop. A SHIP near 59°N, 47°W, reported 52-kn easterly winds. On the 4th the MEERKATZE (59°N, 46°W) and the MERCANDIAN CLIPPER (59°N, 48°W) had 50-kn easterlies with 21-ft seas. As the LOW completed the loop on the 5th, it died.

A storm moved northeastward out of the Gulf of Mexico on the 4th and broke into two centers. While on the Gulf Coast it produced tornadoes and heavy rain over Mississippi and Louisiana (fig. 79). Mobile, Ala., had

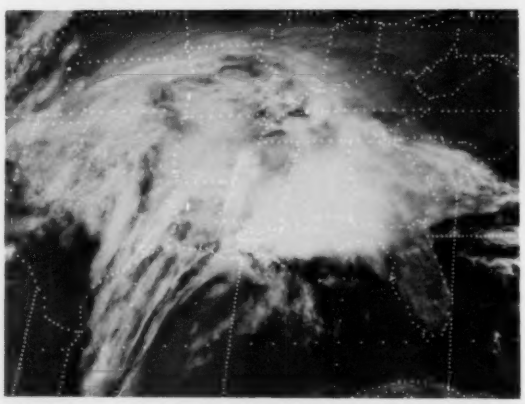


Figure 79.--The severe weather and heavy rains were under the very bright clouds over Mississippi and Alabama.

3.5 in in 2 hr. There were several cases of 3 to 6 in in 6 hr. Van Cleave, Miss., had 7.82 in in 10 hr. Many areas were flooded and some required evacuation.

The original LOW moved northward west of the Appalachian Mountains, and the new LOW developed over the Carolinas. At 0000 on the 6th, the 994-mb LOW was near 39°N, 68°W. The HAHNENTOR (37°N, 56°W) had 42-kn winds. At 0600 the MARINE NAUTICA (47°N, 60°W) northeast of the center found 50-kn storm winds (fig. 80).

The storm had moved to 40°N, 50°W, by 1200 on the 7th. It passed over the AMERICAN LEGEND which had 45-kn northerly winds at this time. The seas were reported as 28 ft and the swells 20 ft. On the 8th the ARCTIC TROLL was west of the LOW with 60-kn winds out of the north. The TOM JACOB was being washed down by 60-kn northerly winds driving heavy rain near 50°N, 39°W, on the 9th. The waves were 20 ft. The stronger winds in this storm appeared to be west of the center. At 1200 the center of the 993-mb storm was within 2 mb of OWS Charlie. At 1800 the winds were measured as 45 kn with 21-ft seas. The 40- to 50-kn winds continued through the 10th and 11th as the storm moved over Iceland. It lost its punch over the Norwegian Sea, where it meandered until the 15th.

During the middle of the month high pressure settled east of Newfoundland blocking any severe LOWs. It slowly drifted toward its normal position near the Azores Islands.

A LOW center formed over Europe in the northern part of a trough connected with low pressure over North Africa on the 22d. It remained virtually stationary and deepened as the Azores High drifted southeastward. This resulted in a tight pressure gradient off Europe's west coast. On the 23d ships were reporting 40- to 60-kn winds off Portugal and Spain. Two reported winds of about 60 kn. They were the GORNIK and FAPI near 37°N, 09°W. Others had gales in the 40-kn category. OWS Romeo was tossed by 20-ft seas. On the 24th the LOW appeared to leap into the Balkins weakening the gradient.

This storm formed in the lee of the Rocky Mountains over the Plains States on the 18th. As the center neared the coast on the 22d a Norwegian ship had 44-kn winds near Sable Island (fig. 81). At 1200 the 982-mb LOW was over the Strait of Belle Isle. Two Canadian ships, the HUDSON and NORTHERNSHELL, were near 47°N, 55°W, with 40-kn westerly winds. On the 23d the LOW stalled over the Labrador Sea for 24 hr. A Danish ship was in the Davis Strait with 60-kn winds from the northwest. The VASSIA CHICHKOVSKII near 53°N, 45°W, reported 20-ft seas. On the 26th another LOW took over the circulation.

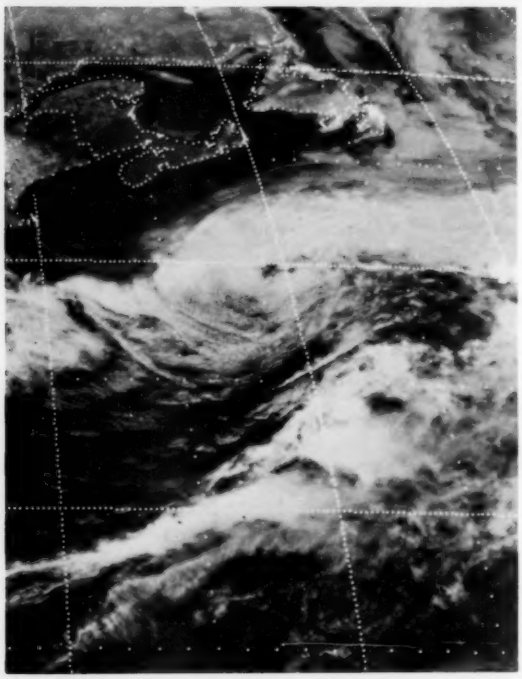


Figure 80.--At 1700 on the 6th the original storm is over the Great Lakes, and the LOW of interest to ships is at 40°N, 60°W.

Figure 81.--The storm's center is near Newfoundland. The high winds were in the clear air behind the sharp frontal boundary.

Casualties--The British cargo ship PHOTINIA (10,506 tons) (fig. 82) anchored south of Milwaukee in Lake Michigan dragged anchor and went aground in winds up to 50 kn and waves of 6 to 8 ft.

Figure 82.--The British cargo ship PHOTINA is shown aground in stormy Lake Michigan off Milwaukee. The ship dragged anchor in high winds and waves. The crew of 33 was off. Wide World Photo.

# Rough Log, North Pacific Weather

## April and May 1978

ROUGH LOG, APRIL 1978--The mean paths of the extratropical cyclone centers this month were close to a carbon copy of the climatological mean. The primary and most-traveled path extended from south of Kyushu to the Andreanof and Pribilof Islands. An eastward-oriented secondary path from the Tsugaru Strait joined this one. The storm centers over the Gulf of Alaska were not so clearly cut, as they tended to circle off Queen Charlotte Sound. Two lonely, widely separated storms formed to the north and west of the Hawaiian Islands. One moved to off the northern California coast, but did not cross it.

The climatic pressure pattern indicates multiple centers for both the Aleutian Low and the Pacific High. This month the mean only indicated one center in each. According to 1948 to 1970 climatological normals, the Aleutian Low has four 1009- to 1010-mb centers stretched east to west across the Bering Sea. This month the single center of circulation was 1002 mb near 55°N, 180°. The Pacific High usually has three centers of about 1022 mb, but this month they were replaced by one 1026-mb center near 37°N, 150°W.

The largest anomaly center was minus 8 mb near the Low center. A minus 6-mb center near 43°N, 168°E, reflected a sharper troughing action in the area. Southeast of Vancouver Island, a minus 3-mb anomaly center resulted from the cyclones circling in that area, thus extending the time that they affected it. The only significant positive anomaly was 4 mb, centered near 40°N north of Hawaii.

A closed Low over the Bering Sea replaced the normal trough at 700 mb. A sharp, short-wave trough and ridge paralleled the North American coast from Washington State northward. The inflection point was almost directly over the coast. The High was several meters higher than normal. This with the deeper closed Low produced a tighter gradient and higher upper air winds.

Typhoon Olive formed east of the Philippines in the third week of the month.

Extratropical Cyclones--On the first day of the month a LOW center was moving along the Aleutian Islands. A sharp trough extended southwestward, and two new centers formed in this trough. The northern one survived and at 1200 was near 38°N, 167°E. At that time the LOW turned sharply northward and quickly deepened with a large circulation. The JAPAN RAINBOW was west of the center with 50-kn winds and snow showers at 0000 on the 2d. South of the LOW near 38°N, the ANCO DUKE was sailing westward into 47-kn gales and 25-ft seas and swells. At 0600 the JAPAN RAINBOW reported 68-kn northwesterly winds near 48°N, 164°E. By 0000 on the 3d, the 958-mb center was crossing the 55th parallel near 173°E and turning eastward. A ship about 150 mi south of the center was tossed by 33-ft seas. The PRESIDENT MADISON and SEA-LAND COMMERCE were both involved with the storm with 40- to 45-kn winds. The STAR BULFORD about 250 mi southeast of the center had 60-kn winds and 26-ft seas. Winds of 40 to 50 kn and seas up to 30 ft continued into the 4th (fig. 83). The DON CARLOS (51°N, 171°E) took the honors with 36-ft seas. The JAPAN RAINBOW was keeping pace with the storm, and early on the 4th her radio messages indicated 78- and 87-kn winds along 49°N. Late on the 4th the storm died over the cold Bering Sea.

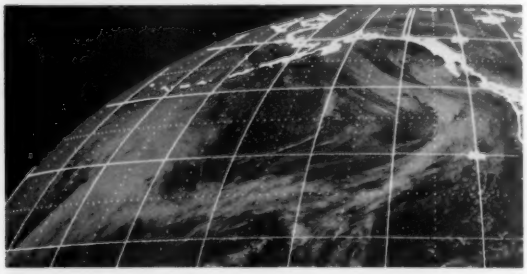


Figure 83.--The dying storm is barely discernible over the Bering Sea. There is a wave on the front near 50°N, 145°W, and a LOW centered near Vancouver Island. The next storm can be seen near 175°E.

In the meantime another storm was harassing ships off the coast of Japan. It formed on an extension of the front associated with the previous storm, near Okinawa. High wind and wave reports from this storm started on the 3d, while its center was only a few miles south and east of Tokyo. Over 20 ships reported winds of 40 kn or greater between 30° and 37°N and mostly between 140°E and 145°E. The highest wind was 66 kn near 36°N, 142°E, and the highest wave was 31 ft near 34°N, 149°E. At 1200 the storm was 987 mb near 36°N, 146°E. The high winds and waves continued through the 4th. The PRESIDENT VAN BUREN (35°N, 145°E) reported no seas, but the winds were 60 kn out of the northwest. The HAKONE MARU at 35°N, 152°W, was plowing into 33-ft swell waves.

On the 5th the winds were not quite so strong; but the waves, particularly the swell, persisted and increased. The NEPTUNE TOPAZ near 34°N, 161°E, was pounding into 39-ft swells. The LOW split into two centers on the 1200 analysis, and the northern one took over the circulation on the 6th. At 0000 both were 966 mb. The PRESIDENT ROOSEVELT was 1,000 mi to the south near 36°N, 176°E, with 23-ft seas. The storm was north of the Aleutians and traveling east-northeastward. On the 7th the HAKUZAN MARU was 200 mi south of the center with 45-kn southwesterlies and 33-ft swells. The center stalled for 24 hr over Bristol Bay on the 8th. Two ships and a buoy reported seas and swells from 20 to 28 ft south of the Alaska Peninsula. The storm moved over the Yukon River on the 10th and filled.

This storm originated far inland near Lake Baykal in the U.S.S.R. On the 6th it moved over the Sea of Japan--a well-developed storm. The WYOMING was sailing eastward with 18-ft waves slapping her starboard side. The stronger winds were in the southerly flow and at 1800 a ship was hit by 34-ft swells east of Hokkaido. Two ships reported 33-ft swells on the 7th. The BRANFF (38°N, 152°E) was south of the warm front and east of the cold front, and the other SHIP was west of the cold front near 33°N, 146°E. Most of the higher winds were in the gale category. As the storm crossed the Kurile Islands, it started to break up into multiple centers. On the 8th no principal center was evident.

The East China Sea provided this contribution to marine weather. This storm developed as a frontal wave off Shanghai on the 10th. There were a few gale reports on the 12th as the storm sailed eastward south of Tokyo. By 0000 on the 13th, it was 988 mb and consolidating its circulation. The TAKARA was northwest of the center with 50-kn winds and 30-ft seas and swells out of the east. A ship south of the center and slightly east of the front suffered with 25-ft swell waves. The storm continued slowly eastward and was 986 mb at 1200 on the 15th near 42°N, 167°E. The winds and waves were increasing. The AMERICAN LANCER (46°N, 173°E) found 68-kn southeasterly winds. The N.R. CRUMP was west of the center with 31-ft seas from the northwest. A ship in the southwest quadrant found 25-ft seas. The winds were in the 40- to 50-kn range. On the 16th the storm suddenly deteriorated to a trough as part of another LOW.

The valley of the Yellow River was the birthplace of this storm. It moved across Hokkaido on the 16th. There were a few wind reports in the 40-kn range as it crossed the Yellow Sea and the Sea of Japan. It raced to near 51°N, 164°E, by 1200 on the 17th. The ASIA GOLD found 50-kn winds near 45°N, 154°E, about 300 mi south of the storm's center.

At 0000 on the 18th the VAN WARRIOR (48°N, 171°E) was sailing into 60-kn westerlies. A SHIP near 162°E had 33-ft seas and swells. About this time the center moved ashore on eastern Siberia and almost disappeared. A small circulation managed to survive until the 22d.

The northern ocean was cut into many small LOWs for about a week before another large, strong cyclone developed. On the 26th several of these combined into

one cyclone near 44°N, 162°E. At 0600 two ships near 44°N, 147°E, had northerly 58- and 60-kn winds. At 1200 the EHIME MARU and HIKAWA MARU near 41°N, 152°E, were riding dangerous 26- to 30-ft waves. On the 27th the winds continued in the 40- to 50-kn range with 20- to 30-ft waves.

On the 1200 analysis of the 27th a LOW had formed at the point of occlusion and was speeding eastward (fig. 84). The ACT 1 was stationary near 41°N, 163°E, with 33-ft swells. The last significant wave report with this center was 21 ft. By the 29th it had dissipated. The new LOW moved into the Gulf of Alaska.

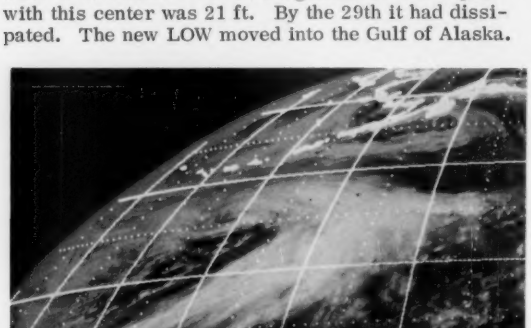


Figure 84.--The storm is centered near 45°N, 170°W, at 2045 on the 27th.

This LOW formed on the 29th as a frontal wave near 34°N, 180°, southeast of a large HIGH centered over the Kurile Islands. It raced northeastward into the Gulf of Alaska. At 0000 on May 1 a ship near 43°N, 153°W, found 20-ft swells. At 0600 a ship off Vancouver Island had 23-ft swells. Ocean Weather Station Papa measured 50-kn winds at 0900. At 1200 the ARCO ANCHORAGE near the 978-mb center had a pressure of 983 mb with 45-kn winds and 25-ft swells. At 1800 there were five reports of winds of 40 to 50 kn around the storm, mostly in the southeast quadrant. The seas that were reported were from 20 to 34 ft. At 0000 on the 2d, the ARCO ANCHORAGE was sailing southward with 41-ft swells pounding her starboard side. The winds were not particularly strong, but the waves remained at 20 to 30 ft. At midday the storm crossed the Alaska coast and circled westward to dissipate.

Tropical Cyclones, Western Pacific--Typhoon Olive began in a broken cluster of convective cells on the 17th, just west of Yap Island. Within 24 hr she was at tropical-storm strength on a west northwestward course. She intensified slowly during the next several days. On the 19th and 20th Olive moved through the central Philippines. Once out over the South China Sea she strengthened rapidly. Olive became the first typhoon of the year on the 22d. About this same time she began to recurve, northward then northeastward. Her maximum winds climbed to a peak of 85 kn on the 23d and 24th (fig. 85). On the 25th Olive passed through the Luzon Strait heading east-northeastward. She was showing signs of weakening. The following day Olive was a tropical storm and becoming extratropical.

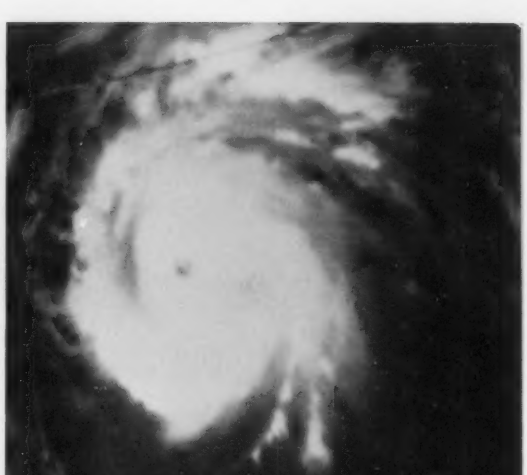


Figure 85.--This image of Olive at her peak was snapped early on the 23d.

Casualties--The 4,938-ton British ALAUNIA sustained heavy weather damage on the 5th and 6th. Flooding caused damage to steering gear. South of the Equator, the 14,072-ton Australian ALLUNGA broke five aft mooring lines, pulled out one shore bollard, and fractured another during a severe squall at Suva, Fiji Islands on the 16th. The British-registered PORT VANCOUVER (35,716 tons) was at Kobe on the 25th with heavy weather damage, and weather damage to the bow of the American container barge ISLANDER was discovered while she was in drydock.

ROUGH LOG, MAY 1978--The North Pacific suffered rougher weather this month than the North Atlantic. The storm paths were spread out, but they generally followed the climatological orientation. The primary path formed south of Japan and extended northeastward into the Gulf of Alaska. A few storms entered the Bering Sea. Also, several storms formed in midocean and contributed to those entering the Gulf of Alaska.

The mean-pressure pattern varied from the long-range climatology. Normally, there are three low centers of 1009 mb that comprise the Aleutian Low. This month there was one 1007-mb LOW over the Alaska Peninsula. The Pacific High was larger than usual and 5 mb higher in pressure at 1028 mb. The main center was near 39°N, 140°W, about 500 mi northeast of its usual position. A second 1026-mb center was near 35°N, 172°W.

The larger anomaly centers were positive. A positive 7 mb was near 46°N, 167°E, and a positive 6 mb was near 40°N, 138°W. Most of the ocean north of 20°N was positive, except for the Gulf of Alaska and eastern Bering Sea. This area had a negative 3-mb center near Kodiak Island.

The upper air pattern at 700 mb had more resemblance to climatology than did the surface. The heights over the central Pacific with the High were about 150

ft higher than normal. The Low over the Bering Sea was shifted eastward to near the Shumagin Islands.

The first tropical cyclone of the season for the eastern North Pacific, hurricane Aletta, formed on the 30th.

Extratropical Cyclones--The first significant storm this month formed on a degenerating stationary front between two cells of the Pacific High on the 4th. At 1200 on the 5th, the 994-mb LOW was squeezing northward between the two HIGHs and was near 42°N, 156°W. The PRESIDENT MONROE was west of the center with 40-kn winds and 15-ft waves. As she passed south of the center at 1800, the winds picked up to 50 kn and the swells to 25 ft. On the 6th there were more reports north and west of the center of winds over 40 kn. Among others the SEA-LAND EXCHANGE reported 45-kn winds near 53°N, 146°W. Buoy 46003 measured 45-kn winds. The waves were 15 to 20 ft. At 1200 the storm reached its lowest pressure of 976 mb (fig. 86). Off the coast of California the NANCY LYKES was on the east side of the HIGH with 33-ft swells. The SHUNWIND was sailing eastward among the Aleutians with 40-kn winds and swells of 30 ft. On the 8th the storm dissipated over Alaska.

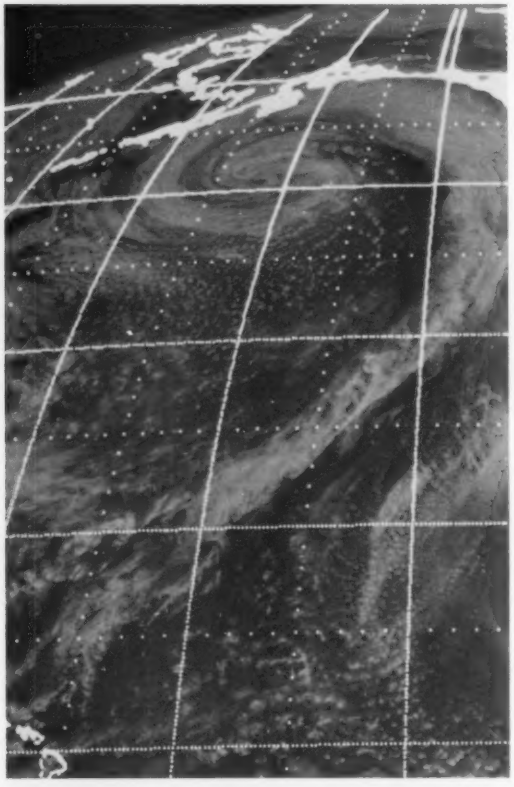


Figure 86.--Clouds coil into the center of the 976-mb storm indicating the flow of the winds.

There were multiple LOW centers west of 170°W on the 6th. These partially consolidated on the 7th into two centers. The PRESIDENT POLK was southwest of the LOW with 40-kn winds and 20-ft seas and swells. At 0000 on the 8th this LOW had become the primary storm at 980 mb near 43°N, 173°W. Four ships had winds of 47 to 50 kn. Two of them reported waves over 30 ft near 41°N, 166°W. On the 9th the SANKOSUN (42°N, 167°W) had 40-kn winds with 30-ft swells (fig. 87). The OPHELIA was east of the occlusion with 68-kn southerly winds. The winds decreased on the 10th to gales as the storm entered the Gulf of Alaska and quickly deteriorated on the 11th.

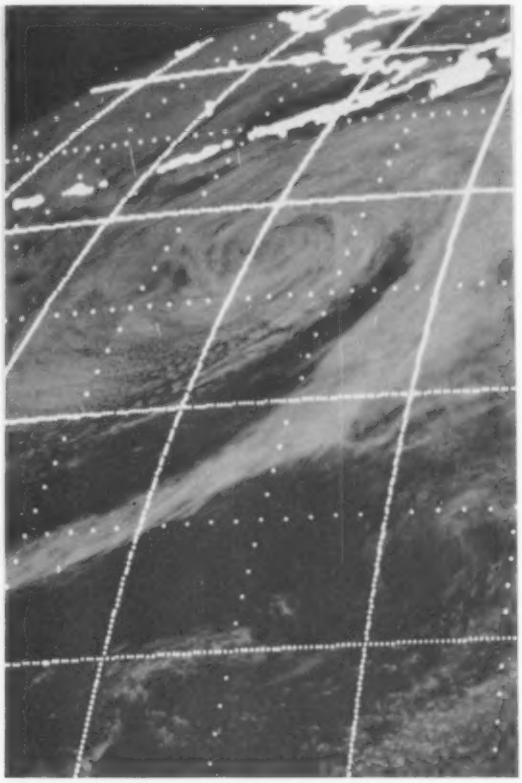


Figure 87.--This image taken from GOES satellite over the Equator at 135°W shows the storm producing the high waves at 47°N, 160°W, at 2045 on the 8th.

A second center, east of Kamchatka, split off of a LOW that was over the Sea of Okhotsk on the 11th. A large HIGH was centered near 40°N, 180°, with a tight pressure gradient on the northwest side. A ship was sailing westward off Hokkaido in fog with 20-ft swells. On the 12th the 990-mb LOW was over the central Bering Sea. The MAMMOTH FIR was south of the LOW near 52°N, 172°W. The winds were only 40 kn, but they were whipping up 30-ft seas.

The HIGH had drifted to 36°N, 172°W, as the LOW stalled over the Bering Sea. The tight pressure gradient had rotated to north of the HIGH as the LOW moved. The TRIUMPH (49°N, 180°) was sailing into 30-kn winds and 26-ft swells near 49°N, 179°E, on the 13th.

On the 12th another LOW had formed to the east of this one and was becoming the primary storm. Late on the 14th the original LOW dissolved on Alaska's west coast.

Monster of the Month--This was the LOW that broke away from the one above. At 0000 on the 13th the storm was 990 mb near 51°N, 155°W. The ATLAS CARRIER was west of the center with 25-ft swells. At 0000 on the 14th the observation of the JAPAN ACE at 43°N, 143°W, indicated a swell height of 49 ft. The winds were 40 kn and the seas 12 ft. The only other comparative swell was 20 ft about 300 mi to the west (fig. 88).

On the 15th the winds were in the 40-kn range. A SHIP near 37°N, 134°W, had 30-ft swells. As the LOW

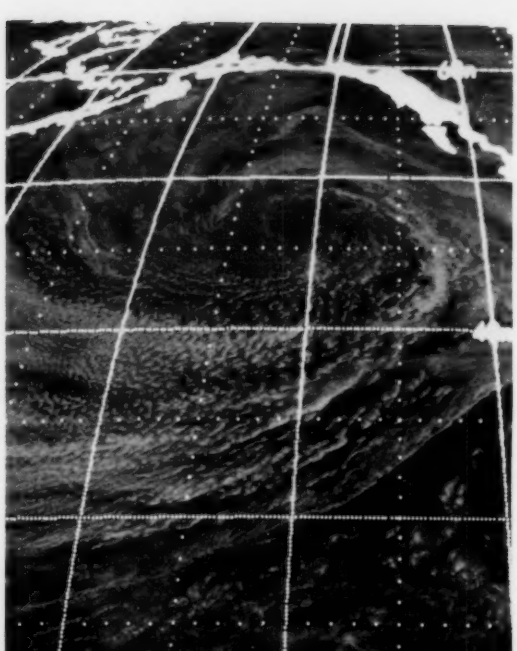


Figure 88.--Near noon on the 13th the scattered cumulus clouds give no indication of the high swell waves below.

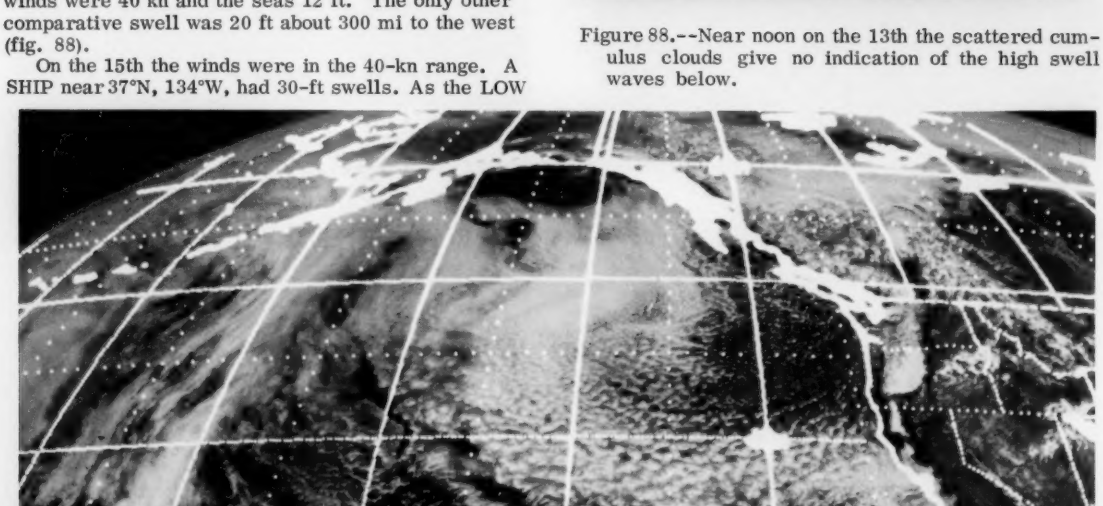


Figure 89.--The 1040-mb HIGH was centered near 45°N, 145°W, at 2045 on the 21st. The northerly circulation along the coast produced high winds and waves. Note the low stratus clouds and fog along the coast and in the coastal valleys.

neared the Oregon coast, it rapidly filled and moved into the mountains.

Another cyclone born in the col area between two high-pressure areas. This one showed up on the analysis of 0000 on the 13th near 45°N, 168°E. On the 14th the GLADIOLUS was east of the cold front with following 45-kn winds. At 0000 on the 15th the 990-mb storm was slightly south of Unimak Island. A ship with the last three call letters of TOH was north of Unimak Island with 30-ft swells. The GRAND FELICITY had 44-kn winds near the dateline at 52°N. The PAN DYNASTI was far south of the storm near 42°N on the 16th with 34-ft swells. Another LOW was approaching from the west to move around the southern periphery. The GLADIOLUS and VAN ENTERPRISE now caught 50-kn winds, and the swells striking the PAN DYNASTI were only 28 ft. By the 17th this LOW had disappeared with the new one replacing it.

During the period of the 18th to the 26th a large HIGH with pressure generally above 1035 mb was entrenched off the U.S. West Coast near 43°N, 143°W (fig. 89). There were several ship reports during this period of northerly winds up to 50 kn and seas or swells up to 25 ft.

There had been a diffuse LOW over the Gulf of Alaska since the 25th. A frontal wave was moving eastward on the southern edge of its circulation, but it could not be identified on the 26th with the data available. On the 0000 chart of the 27th (The 0000 chart always has more reports.) a new LOW was identified near 50°N, 139°W. There were three other small centers across Alaska into the Yukon. The PACGLORY was 600 mi to the southwest with 40-kn winds. Twenty-four hours later the 993-mb storm was near 56°N, 139°W. The GLADIOLUS was now at 51°N, 135°W, and reporting 65-kn winds with 13-ft seas and 16-ft swells. On the 28th the LOW moved over Valdez and drifted northeastward to disappear on the 29th.

Tropical Cyclones, Eastern Pacific--Hurricane Aletta came to life on the 30th south of Acapulco. Satellite photographs indicated that she was intensifying rapidly. Early the following day Aletta was upgraded to a hurricane as 65-kn winds blew around her center, which was meandering northwestward. Aletta brushed the sparsely populated coast between Acapulco and Manzanillo on the 31st (fig. 90). This caused her to weaken. When the main center moved ashore, a second center developed and briefly intensified. However, she quickly lost her strength. By June 1 she had degenerated to an area of active thunderstorms with little detectable circulation.

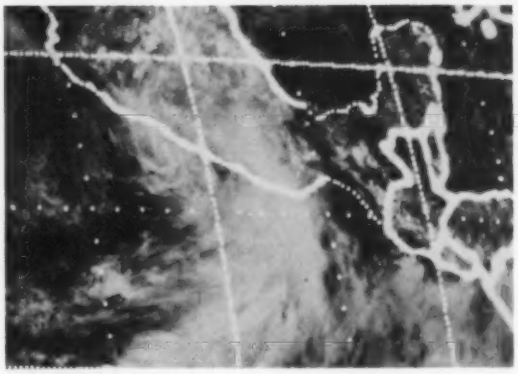


Figure 90.--It appears in this image of 2045 on the 31st that the center of Aletta is directly over the coastline.

Casualties--The 19,734-ton Liberian-registered bulk-carrier SUMMIT VENTURE was at Nagoya on the 18th requesting a survey for heavy weather damage from a voyage from Hampton Roads and Los Angeles.

# Marine Weather Diary

## NORTH ATLANTIC, AUGUST

WEATHER. The favorable weather that is characteristic of summer continues into August, the warmest month of the year over the North Atlantic. The monthly pressure analysis shows the 1022-mb subtropical High centered near 35°N, 43°W, while the Icelandic Low, a broad, flat, east-west trough, reaches its lowest pressure (1008 mb) over Hudson Strait.

WINDS. Over the middle latitudes (40° to 60°N), winds from the southwest through the northwest occur with the greatest frequency. North of latitude 60°N, they become northerly between Greenland and Iceland, and variable south of Iceland and over the southern Norwegian Sea. The prevailing winds over the North Sea are from the westerly quarter of the compass. Between 40° and 25°N, the prevailing direction is from the north and northeast over the extreme eastern Atlantic, and from the south and southwest over the western ocean. Northwesterlies--known by many names, including mistral, etasians, and maestro--blow over the Mediterranean Sea. The northeast trades of the Atlantic lie principally between 25° and 15°N, extending to the South American coast over the Caribbean Sea. Near the approaches to the United States at these latitudes, the trades become more easterly--the Gulf of Mexico has prevailing easterly winds. Southeasterlies are dominant near the Equator, between South America and Africa. Windspeeds on the North Atlantic in August average slightly more than force 3, with lower speeds over the western Mediterranean, the Davis Strait, and the Gulf of Mexico.

GALES. Winds of gale force, except in tropical cyclones, are very infrequent south of 52°N. North of this latitude, gale frequencies of about 5 percent are fairly common, with maximum frequencies of 10 percent or more over the Norwegian Sea and the waters south and west of southern Greenland.

EXTRATROPICAL CYCLONES. A few moderately strong summer LOWs move about north of 40°N. Storms that attain severe intensities during August are usually of tropical origin. Primary storm tracks for extratropical cyclones are from Hudson Bay to Davis Strait, and from east of the James Bay region and the eastern Grand Banks to just south of Iceland and then eastward through southern Scandinavia. A short primary track lies off the U. S. East Coast. A secondary storm track crosses eastern Lake Superior before joining the primary track over central Quebec.

TROPICAL CYCLONES. August is one of the principal months in the North Atlantic hurricane season, ranking second behind September in tropical storm development and also in the number of these storms that attain hurricane force. An average of 2.4 tropical storms occur during August, and 1.5 or 2 out of 3 develop to hurricane intensity. A maximum of seven cyclones occurred in August 1933; and, in contrast, no storms were reported during 1941 and 1961. In general, the level of tropical cyclone activity increases as August advances, with the likelihood of storm occurrence being more than twice as great in the last 10 days as during the first 10 days of the month. The spawning area of tropical cyclones is much larger in August than during the preceding month. Some tropical cyclones originate as disturbances over southwestern portions of the "African Bulge," intensify into tropical depressions southwest of the Cape Verde Islands, gather strength as they are carried across the lower latitudes of the North Atlantic by the prevailing easterlies, and then enter the Caribbean, Gulf of Mexico, Florida, or the western Atlantic, as fully developed hurricanes. A characteristic of this activity is the split mean storm track around the Bahamas, with one branch passing to the north of the islands, where it recurves off Cape Hatteras, and the other over the southern portion of the island chain.

SEA HEIGHTS of 12 ft or more are encountered more than 10 percent of the time over a portion of the northern ocean south of southern Greenland and several hundred miles southwest of Iceland. Two other areas are also observed. One lies west of the British Isles, while the other is hosted by the Denmark Strait.

VISIBILITY. In general, fog is both less frequent and less extensive than earlier in the summer. Percentage frequencies of visibilities less than 2 mi occur 10 percent or more of the time north of a line from Cabot Strait southeastward to include the Grand Banks, thence northeastward to near 50°N, 35°W, northward to 65°N, 35°W, then southeastward to Scotland. The line then extends north- and eastward to the northern coast of Norway. A 20-percent oval-shaped area, about 600 mi in diameter, is centered off Newfoundland near 50°N, 50°W. Another 20-percent area is north of Iceland over the southern Greenland Sea.

## NORTH PACIFIC, AUGUST

WEATHER. Mild summer weather continues over the North Pacific. Fog decreases, but both tropical and extratropical cyclones are more numerous. Temperatures reach their maximum for the year. By the middle of the month, the 1010-mb Aleutian Low has reappeared over the northern Bering Sea, near 61°N, 178°W. The subtropical High (1025 mb) is centered near 38°N, 152°W, in August.

WINDS. The northeast trade winds are the most persistent feature. They prevail south of about 35°N, and to 40°N over the eastern ocean. Over the Philippine and South China Seas, they quickly shift to the southwest monsoon. Off the Asian coast, the winds turn to southerly, and continue to shift to southwesterly over the northern latitudes. Over the western Bering Sea, they are westerly. Over the central ocean north of latitude 40°N, and over the eastern Bering Sea, the prevailing direction is southwesterly. The winds over the Gulf of Alaska are westerly, shifting to northerly along the American coast. Winds of force 3 to 4 generally account for over 50 percent of the speeds.

GALES, although unusual in areas not affected by tropical cyclones, do occur more than 5 percent of the time over the heart of the Bering Sea, along the easternmost capes of Kamchatka, and northwest of the Bering Strait. Owing to the influence of tropical cyclones, another small area of greater-than-5-percent frequency is centered near 25°N, 134°E.

EXTRATROPICAL CYCLONES. The number of extratropical cyclones is slightly higher in August than in the preceding month. Most of these storms form off the coast of Japan and move northeastward into the Bering Sea. Others enter the Bering Sea after developing off the southeastern tip of Kamchatka; these storms often journey as far north as Kotzebue Sound. Still another primary cyclone track scampers toward the Gulf of Alaska from a point near 51°N, 158°W.

TROPICAL CYCLONES. The frequency of tropical cyclones in the western North Pacific reaches a peak in August and September. About five tropical storms can be expected in August; three or four reach typhoon intensity. Typhoons in August are displaced farther to the north than in July and have less of a tendency to pass directly over the northern Philippines. Some move directly toward Japan and Taiwan; others may pass over Japan after recurving over the Yellow Sea. Those storms that do enter the South China Sea usually move west-northwestward into the Gulf of Tonkin and North Vietnam.

Over tropical waters west of Mexico, four or five tropical storms usually occur--a maximum for any month. The average duration of these storms is 6 days, and about half attain hurricane intensity. As in July, cyclones usually move in a west-northwesterly direction out to sea, where they almost always die after meeting colder waters and more stable air. Occasionally, however, one recurves before it has moved too far from the coast and moves inland over Baja California or the Mexican mainland.

SEA HEIGHTS. During August, sea heights of 12 ft or more are rare and occur less than 10 percent of the time across the entire North Pacific Ocean.

VISIBILITY improves very slightly during August. An area about 300 mi in diameter, where the visibility is less than 2 mi over 40 percent of the time, is

centered just south of the Kamchatka Peninsula. The 30-percent line surrounds this area, reaching into the Sea of Okhotsk and to the Near Islands. The 10-percent line includes the southeastern half of the Sea of Okhotsk to 40°N at 160°E, along 40°N to 170°W, to 53°N, 137°W, to the Kenai Peninsula of Alaska. This area includes all of the Bering Sea.

## NORTH ATLANTIC, SEPTEMBER

WEATHER. With the approach of autumn, subdued weather conditions that characterize the summer season over the higher latitudes gradually give way to increased cyclonic activity resulting from moderate intrusions of colder air. The Icelandic Low deepens to about 1006 mb, and is centered roughly halfway between Iceland and southern Greenland. The Azores High (1021 mb), centered near 33°N, 40°W, is a little weaker than in August.

WINDS. Almost without exception, the prevailing winds are westerly between 40° and 60°N. However, over the Grand Banks and the waters east of there to about 40°W, southerly winds prevail, and winds are variable south of Nova Scotia and over the Bay of Biscay. Speeds across this latitudinal belt are generally about force 4. South of 40°N, somewhat lighter winds average about force 3. Wind directions are frequently variable between 30° and 40°N, along the axis of the subtropical High, but northerlies dominate between 20°W and the Strait of Gibraltar. Between 30° and 10°N, easterly winds predominate over the western ocean (northeasterly over the Caribbean Sea), and northeasterly winds are the rule over eastern waters. Northwesterly winds blow over the Mediterranean, and southeasterlies are common over the extreme southern North Atlantic. Northerly winds prevail south of the Denmark Strait, while southwesterlies predominate over the Norwegian Sea. Northwesterly and southeasterly winds are most common over the southern approaches to the Davis Strait. Windspeeds north of 60°N average force 4 east of Greenland, but near the Davis Strait, more reports of force-2 winds are received than of any other speed group.

GALES. The frequency of gales increases in September, particularly over northern latitudes. Frequencies of 10 percent are found just south of Greenland's southern tip, over the open waters between northern Labrador-southern Baffin Island and southwestern Greenland, over the Norwegian Sea, and over the waters north and south of Iceland. The highest frequency, 20 percent, is found over waters well north of Iceland, and over a portion of the Norwegian Sea. Elsewhere, 5-percent frequencies are fairly common north of 50°N. South of 40°N, gales are unlikely to be encountered except in storms of tropical origin.

EXTRATROPICAL CYCLONES are more frequent than in August, and occasional severe storms may be encountered. Primary storm tracks lead northeastward from the waters off Labrador and Newfoundland to southern Iceland, and then over the Norwegian Sea. Another major storm track enters the Davis Strait from the Hudson Bay-northern Quebec region, while a third advances up the Baltic Sea from southern Scandinavia into Russia. One secondary storm track crosses the Straits of Mackinac on its way from the Great Plains to the primary track over Labrador. The storm track off the U.S. East Coast has moved seaward and extends from off Cape Hatteras to Sable Island.

TROPICAL CYCLONES. Tropical storm activity reaches a peak in September. Climatology indicates that an average of 3.3 tropical storms occur in September, 2 of which develop to hurricane strength. As many as seven tropical storms were reported in September (1949), while in 1930 there were none. The entire western ocean is subject to these storms, many of which originate east of the West Indies and move westward over or north of these islands, either to enter the Gulf of Mexico, or to recurve northeastward over western waters. Some storms entering the Gulf recurve over Florida and often parallel the U.S. East Coast. Another breeding ground for tropical cyclones is over the Caribbean, east of Nicaragua. Many tropical storms or hurricanes are still packing considerable punch when they reach northern shipping routes.

SEA HEIGHTS of 12 ft or more have a frequency of 10 percent or higher over most of the North Atlantic between 50° and 65°N, while small areas of 20-percent frequency occur off Greenland's southern tip and over the Denmark Strait.

VISIBILITY. Percentage frequencies of visibility less than 2 mi exceed 10 percent north of a line drawn from the western Labrador Sea eastward to 57°N, 48°W, and then southwestward to encompass all of Newfoundland and the Grand Banks. From there, the line extends north-northeastward to the waters south of the Denmark Strait, and then eastward, barely missing the southern tip of Iceland, before dipping southeastward to include the Pentland Firth and the Hebrides. The line then passes east of the Shetland Islands before entering the Norwegian Sea midway between Iceland and Norway. Percentage frequencies of visibility less than 2 mi decrease to less than 10 percent over the central and northern portions of the Davis Strait, but increase to more than 20 percent over the northern reaches of the Labrador Sea above 60°N, and over the waters north of Iceland, east of the Denmark Strait. Over a small portion of the latter area, near 69°N, 16°W, the percentage frequency of visibility less than 2 mi exceeds 30 percent.

## NORTH PACIFIC, SEPTEMBER

WEATHER over the North Pacific continues to be generally pleasant in early September, but, as the month advances, early winter-type storms occur over the northern shipping lanes. Western portions of these routes are also subject to tropical cyclones. A closed Aleutian Low reappears in September, centered over southwest Alaska, with a central pressure of 1007 mb. The 1021-mb subtropical High, near 36°N, 146°W, has weakened considerably and is centered about 300 mi southeast of its August location.

WINDS. The prevailing winds over the middle latitudes of 40° to 60°N are from the western quadrant, shifting to more southerly near the Asian coast, and northerly near the American coast. Over the Bering Sea, they are northwesterly, shifting to northerly over the Bering Strait. The northeast trade winds are

predominant south of 30°N, shifting to the north along the American coast, and southwesterly winds predominate over the southern Philippine Sea and South China Sea, where the southwest monsoon is firmly established. There are two areas where the winds appear to be out of phase. One is the northern Gulf of Alaska, with prevailing easterlies; and the other is along the coast of southern China and the East China Sea, with northeasterlies. The average speed is force 3 to 4.

GALES. Winds of 34 kt or higher are encountered between 5 and 10 percent of the time over much of the open Pacific north of about 45° to 50°N over eastern waters, and between about 37° and 45°N over western waters. A typhoon-influenced area of frequencies greater than 5 percent extends from the East China Sea to the Philippine Sea.

EXTRATROPICAL CYCLONES. Well-developed extratropical storms occur more frequently in September than in August. Most of these move northeastward from the Japanese Islands to pass over southwestern Alaska. Others enter the Gulf of Alaska from the waters south of the eastern Aleutians. Storm tracks are displaced southeastward from those of August.

TROPICAL CYCLONES. On the average, four or five tropical storms can be expected in the western North Pacific in September, almost as many as in August. About three of these will achieve typhoon strength. These storms usually originate in the lower latitudes west of about 150°E, and initially move west-northwestward. Some travel across the northern Philippines and the South China Sea, while others recurve in the vicinity of the Philippine Sea to pass over or near the Japanese Islands.

About three tropical storms will whirl off the Mexican coast in any given September. One or sometimes two will usually become a hurricane. These storms either originate over the waters off southern Mexico and move northwestward parallel to the coast (and sometimes inland), or develop near the Revillagigedo Islands and move westward out over the open ocean.

SEA HEIGHTS of 12 ft or more are common 2 to 10 percent of the time north of about 35°N over eastern waters, and north of about 30°N over western waters (excluding the Bering Sea)--as well as over the South and East China Seas, the Gulf of Tehuantepec, and the lower Gulf of California. Two areas of maximum frequency greater than 10 percent are within an elliptically shaped area between 46° and 50°N, and 162° and 179°E, and over the Okhotsk Basin.

VISIBILITY. Fog is less prevalent in September than in August, but it is still frequent north of about 40°N. Frequencies of 10 percent or more of visibility less than 2 mi are common over the waters between 40°N and the Bering Strait, west of 145°W, and east of 150°E. However, the Alaska Peninsula and the Gulf of Alaska, included within the above area, host frequencies of less than 10 percent. A region of frequencies greater than 20 percent surrounds the waters of southern Kamchatka southwestward to the central Kurils, then eastward to Ostrov Beringa.

## GLOSSARY

GLOSSARY OF METEOROLOGICAL TERMS USED IN THE SMOOTH LOGS, ROUGH LOGS, AND THE MARINE WEATHER DIARY

From time to time as space permits a glossary defining some of the more technical meteorological terms used in the monthly weather summaries will appear in the Mariners Weather Log. This glossary will contain words or groups of words which your editor feels are the most difficult to grasp.

The set of terms appears in alphabetical order. Should omissions occur, we will be happy to define any other troublesome expressions which are brought to our attention.

Alberta LOW--A LOW centered on the eastern slope of the Canadian Rockies in the province of Alberta, Canada.

Formerly, it was thought that such LOWS actually originated (more or less independently) over this location. It is now recognized that depressions moving inland from the Pacific are the actual parent systems. Alberta LOWS appear as these systems enhance, or are enhanced by, the dynamic trough, which is a typical, almost semipermanent, feature of this region.

anomaly--the deviation from normal of pressure, temperature, precipitation, etc., in a given region over a specified period.

anticyclone (High or HIGH)--a closed atmospheric circulation containing higher pressure than its surroundings, having a sense of rotation opposite to that of the earth's rotation: that is, clockwise in the Northern Hemisphere, counterclockwise in the Southern Hemisphere, undefined at the Equator.

backing--a change in wind direction in a counterclockwise sense (e.g., south to southeast to east) in either hemisphere of the earth; the opposite of veering.

center of action--any one of the semipermanent Highs and Lows that appear on mean charts of sea level pressure. The main centers of action (differentiated in the text from all-capitalized synoptic-type LOWS and HIGHS by capitalization of only initial letters) in the Northern Hemisphere are the Icelandic Low, the Aleutian Low, the Azores High, the Pacific High, the Siberian High (in winter), and the Asiatic Low (in summer). Fluctuations in the nature of these centers and other less intense systems are intimately associated with relatively widespread and long-term weather changes.

cold front--any nonoccluded front, or portion thereof, that moves so that colder air replaces warmer air; i.e., the leading edge of a relatively cold air mass.

Colorado LOW--A LOW which makes its first appearance as a definite center in the vicinity of Colorado on the eastern slopes of the Rocky Mountains. It is, in most aspects, analogous to the Alberta LOW.

convection--atmospheric motions that are predominately upward vertical, resulting in vertical transport and mixing of atmospheric properties, sometimes producing convective clouds; e.g., cumulus.

cut-off LOW--a cold LOW in the upper atmosphere which has become displaced out of the basic westerly current, and lies to the south of this current.

cyclogenesis--any development or strengthening of cyclonic circulation in the atmosphere; the opposite of cyclolysis. It is applied to the development of cyclonic circulation where previously it did not exist (commonly, the initial appearance of a LOW or trough), as well as to the intensification of existing cyclonic flow. While cyclogenesis usually occurs together with deepening (a decrease in atmospheric pressure), the two terms should not be used synonymously.

cyclolysis--any weakening of cyclonic circulation in the atmosphere; the opposite of cyclogenesis. Cyclolysis, which refers to the circulation, is to be distinguished from filling, an increase in atmospheric pressure, although the two processes commonly occur simultaneously.

cyclone (Low or LOW)--a closed atmospheric circulation containing lower pressure than its surroundings, having a sense of rotation the same as that of the earth's rotation: that is, as viewed from above, counterclockwise in the Northern Hemisphere, clockwise in the Southern Hemisphere, undefined at the Equator.

cyclone family--a series of wave cyclones occurring in the interval between two successive major outbreaks of polar air. The series travels along the polar front (the front separating air masses of tropical and polar origin), usually eastward and poleward.

Typically, the polar front drifts eastward and equatorward, so that each cyclone of the family has its origin and trajectory at a lower latitude than the previous cyclone.

dynamic trough (lee trough)--A pressure trough that forms on the lee side of a mountain range across which the wind is blowing almost at right angles; often seen on U.S. weather maps east of the Rocky Mountains, and sometimes east of the Appalachians, where it is less pronounced.

Its formation may be explained by the warming owing to the compression of the sinking air on the lee side of the mountain range, or by the generation of cyclonic circulation (cyclogenesis) caused by the horizontal convergence associated with the vertical stretching of air columns descending the lee slope.

extratropical--typical of occurrences poleward of the belt of tropical easterlies. When applied to cyclones, this term refers to the migratory frontal cyclones of middle and high latitudes.

filling--an increase in the central pressure of a pressure system. The term is commonly applied to a LOW (Low) rather than a HIGH (High).

meridional--longitudinal, northerly or southerly; opposed to zonal.

mistral--a north wind which blows down the Rhone Valley south of Valence, France, and then over the Gulf of Lions. It is strong, squally, cold, and dry. A general mistral usually begins with the development of a depression over the Tyrrhenian Sea or Gulf of Genoa with an anticyclone advancing from the Azores to central France. It often exceeds 50 kt; it reaches 70 kt in the lower Rhone Valley and 40 kt at Marseilles, decreasing both east and west and out to sea. A general mistral usually lasts for several days, sometimes with short lulls. It is most violent in winter and spring, and may do considerable damage.

monsoon--a name for seasonal winds. It was first applied to the winds over the Arabian Sea, which blow for 6 mo from the northeast and for 6 mo from the southwest, but it has been extended to similar winds in other parts of the world. The monsoons are strongest on the southern and eastern sides of Asia, the largest land mass, but monsoons also occur on the coasts of tropical regions wherever the planetary circulation is not strong enough to inhibit them. The primary cause of a monsoon is the much greater annual variation of temperature over large land areas compared with neighboring ocean surfaces, causing an excess of pressure over the continents in winter and a deficit in summer, but other factors such as the relief features of the land have a considerable effect.

northeast trades (trade winds, trades)--the wind system, occupying most of the Tropics of the Northern Hemisphere, which blows from the Azores High or Pacific High toward the equatorial trough; a major component of the general circulation of the atmosphere.

The trade winds are best developed on the eastern and equatorial sides of the great subtropical highs, especially over the Atlantic. They begin as north-northeast winds at about latitude 30° in January and latitude 35° in July, gradually veering to northeast and east-northeast as they approach the Equator. Their southern limit is a few degrees north of the Equator. Over the Pacific, the trade winds are properly developed only in the eastern half of that ocean.

The northeast trades are characterized by great constancy of direction and, to a lesser degree, speed; the trades are the most consistent wind system on earth.

norther--in the southern United States, especially in Texas (Texas norther), in the Gulf of Mexico, in the Gulf of Panama away from the coast, and in Central America (norte), the norther is a strong cold wind from between northeast and northwest. It occurs between November and April, freshening during the afternoon and decreasing at night. It is a cold air outbreak associated with the southward movement of a cold anticyclone. It is usually preceded by a warm and cloudy or rainy spell with southerly winds. The norther comes as a rushing blast and brings a sudden

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drop of temperature of a[illegible]ld; winds exceeding 50° F. in 3 hr, in winter. [illegible] rains are torrential.

occluded front (occlusion)--a composite of two fronts, formed as a cold front overtakes a warm front or quasi-stationary front. This is a common process in the late stages of wave cyclone development.

prevailing wind--the wind direction most frequently observed during a given period.

primary cyclone--any cyclone, especially one associated with a front, within whose circulation one or more secondary cyclones have developed. See secondary cyclone.

quasi-stationary front (LOW)--a front or LOW which is stationary or nearly so. Conventionally, one which is moving at a speed less than about 5 kt is generally considered to be quasi-stationary.

ridge (wedge)--an elongated area of relatively high atmospheric pressure, almost always associated with an area of maximum anticyclonic curvature of wind flow, similar to a high but not containing its closed circulation.

secondary cyclone--a cyclone which forms near, or in association with, a primary cyclone.

supertyphoon--a typhoon which attains sustained wind speeds of 130 kt or more.

tehuantepecer--a violent squally wind from the north or north-northeast in the Gulf of Tehuantepec (south of southern Mexico) in winter. It originates in the Gulf of Mexico as a norther which crosses the isthmus and blows through the gap between the Mexican and Guatamalan mountains. It may be felt up to 100 mi out at sea.

triple point--a junction point of three distinct air masses, considered to be an ideal point of origin for a cyclone; i.e., near the junction of an occluded front, cold front, and warm front.

tropical--typical of occurrences within the belt of tropical easterlies. When applied to cyclones, refers to a cyclone that originates over the tropical oceans. At maturity, the tropical cyclone is one of the most

By international agreement, tropical cyclones have been classified according to their intensity as follows: a) tropical disturbance, having a slight surface circulation and one closed isobar (a line of equal or constant pressure) or none at all; b) tropical depression, with winds equal to or less than 33 kt, and with one or more closed isobars; c) tropical storm, with winds of 34-63 kt; d) hurricane or typhoon, with winds of 64 kt or higher.

trough--an elongated area of relatively low atmospheric pressure similar to a low but not containing its closed circulation. As portrayed on a Northern Hemisphere synoptic chart, a trough in midlatitudes normally dips southward. In low or very high latitudes, troughs (inverted) usually push northward.

veering--a change in wind direction in a clockwise sense (e.g., south to southwest to west) in either hemisphere of the earth; the opposite of backing.

wall cloud--the doughnut-shaped ring of clouds surrounding the eye of a fully-developed tropical cyclone. The strongest winds and the largest pressure gradient are usually found here.

warm front--any nonoccluded front, or portion thereof, which moves in such a way that warmer air replaces colder air.

warm sector--that area, within the circulation of a wave cyclone, where the warm air is found. It lies between the cold front and warm front of the storm; and, in the typical case, the warm sector continually diminishes in size and ultimately disappears (at the surface) as the result of occlusion.

wave cyclone--a cyclone which forms on and moves along a front. The circulation about the cyclone center tends to produce a wavelike deformation of the front. The early stage in the development of a wave cyclone or a poorly developed wave cyclone is called a wave disturbance.

zonal--latitudinal; easterly or westerly; opposed to meridional.